Deloro Mine Site Cleanup
Integrated Cleanup Plan
Draft Report – Version 2

Prepared for:

ONTARIO MINISTRY OF THE ENVIRONMENT

Prepared by:

CH2MHILL

Responsible Solutions for a Sustainable Future®

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Executive Summary

Background

The Deloro Mine/Refinery Site, located in Eastern Ontario, began operation as a gold mine in the 1860s. Over the next 100 years, site activities also included the smelting and refining of a number of other elements including arsenic, silver, and cobalt. Activities associated with the mining, smelting, and refining of metals ceased in the 1950s. These historical activities at the site have resulted in significant environmental impacts to the soil, groundwater, surface water, and sediment quality both onsite and offsite.

Abandonment of the site by its owner(s) forced the Ontario Ministry of the Environment (MOE) to take control of the property in 1979 and to initiate control measures to limit the environmental impact from the site. Remedial initiatives by the MOE have resulted in reductions of arsenic loadings to the Moira River. Arsenic loading to the Moira River has been reduced by more than 80 percent from an annual average of 52.1 kg/day in 1979 to an annual average of less than 10 kg/day since 1983.

To provide further treatment, and to mitigate any unacceptable impacts on human health and the environment, CH2M HILL Canada Limited (CH2M HILL) was retained by the MOE to develop and implement a comprehensive rehabilitation program focusing on four individual areas of concern at the Deloro Mine Site. These areas included the Industrial Area, Mine Area, Tailings Area, and Young's Creek Area.

Deloro Mine Site Cleanup Objective

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site so as to mitigate, within reason, any unacceptable impacts on human health or the environment. The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to meet current/interim Provincial Water Quality Objectives (PWQO) in the Moira River downstream of the site.

As part of this overall objective, several area-specific objectives have been developed. Achieving these objectives, in conjunction with the other area-specific objectives, will aid in the successful rehabilitation of the Deloro Mine Site.

Closure Plan for Each Area

Closure Plans have been developed for each of the four areas of the site. The Closure Plans describe the key components of the recommended rehabilitation alternatives developed for each area which have been developed to the preliminary design level. The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans and this Integrated Cleanup Plan (ICP) may need to be revised as a result of the public consultation and stakeholder review, and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment (SSRA) and groundwater modelling studies. Revisions are expected to refine the recommended**

alternative for each main area of the site but not result in a fundamental change in direction. The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

A Closure Plan has been developed for each area of the site based on the recommended rehabilitation alternative identified in Table E.1.

TABLE E.1
RECOMMENDED REHABILITATION ALTERNATIVE FOR EACH AREA

Industrial Area:
Consolidate and cover wastes with an engineered cover augmented with groundwater and surface water flow diversion to enhance the existing collection/treatment system
Mine Area:
Relocation/consolidation of highly leachable waste (HLW) to the Industrial Area, placement of a soil cover in the remaining areas, and treatment of groundwater from the Tuttle Shaft
Tailings Area:
Cover tailings with an engineered soil cover combined with collection/treatment of groundwater and upstream surface water flow diversion
Young's Creek Area:
Full depth excavation of onsite residues, shallow depth excavation of offsite residues, residue disposal in a new onsite engineered containment facility followed by creek rehabilitation

Purpose of this Integrated Cleanup Plan

This report is an ICP that assimilates and integrates the four area-based Closure Plans to provide a comprehensive summary of the cleanup efforts planned for the entire Deloro Mine Site (and related offsite areas). In addition to summarizing the area-based plans, the ICP was developed to consider logistics and to capitalize on synergies between the various plans. The ICP includes optimization and prioritization of remedial actions across the affected areas.

Integrated Cleanup Schedule

An integrated cleanup schedule was developed based on:

- Work packages and implementation schedules prepared for the four main areas of the site
- Consideration of several elements pertaining to the prioritization and optimization of cleanup activities on a site-wide basis

The factors contributing to the development of an integrated schedule are presented and discussed. As a result, it was concluded that a three-year construction period was the shortest period achievable given the competing factors affecting the implementation plan. The schedule can be readily adapted for implementation over a longer period, should this be desirable. However, it is unlikely that work can be sequenced to allow a duration shorter than three years. As a result, a hypothetical three-year construction schedule has been developed to illustrate how the work could be sequenced and to demonstrate that this construction period is achievable. The actual implementation plan will be developed as the construction period approaches.

Sequencing of Work Packages

The recommended cleanup plan has been divided into a series of 31 work packages which can be contracted individually or bundled. The work packages that will be addressed or implemented on an annual basis, as part of the site-wide cleanup, as well as the progress of the site-wide cleanup over the proposed three-year construction period, are shown in the remediation activity plans.

Cost Summary

The cost opinion for the capital cost to undertake the site-wide cleanup is $37,757,892 in 2004 dollars with annual (weighted) operation, maintenance, and monitoring (OMM) costs of $1,089,167. The net present value (NPV) of this remediation work, assuming an effective interest rate of 5 percent and a planning horizon of 20 years is $52,430,914.

The cost opinion includes overhead and remote location costs, a 15 percent contingency for the capital costs, a 5 percent contingency for the OMM costs, and the cost of insurance and various construction bonds associated with the work. The federal Goods and Services Tax (GST) is not included in the cost opinion. The costs presented are expected to have accuracy on the order of +/-25 percent.

The capital costs for the estimated years of cleanup are:

- Year 1 (2007): $14,745,735
- Year 2 (2008): $13,851,468
- Year 3 (2009): $9,160,689

Estimated Total Capital Cost: $37,757,892

Key Performance Indicators

The ability of the design components of each recommended alternative to achieve or support the closure objectives presented in the ICP are examined below in terms of key performance indicators. The key performance indicators are drawn from the respective Closure Plans and are expressed in qualitative (e.g. design approach) and quantitative terms (e.g. modelling results).

All of the low-level radioactive materials will be excavated and/or covered in the Industrial Area and other areas of the site such that the radiation fields will be reduced to less than 0.12 μSv/h, the upper limit of background levels at the site, and to normal background levels of 0.03 to 0.06 μSv/h, if possible.

Industrial Area

Key performance indicators for the Industrial Area include:

- Capping of the entire Industrial Area eliminates contact of surface water runoff with highly leachable and marginally leachable wastes/soils
- The engineered cap/hybrid poplar trees (over consolidated highly leachable waste [HLW]) will allow only approximately 4 percent infiltration of annual precipitation

- The passive groundwater interceptor well network (GIWN) will:
  - Intercept approximately 960 m^3/day on unimpacted groundwater before passing through the site
  - Completely dewater wastes and overburden, together with existing pumping stations
  - Result in relatively low interference with the Deloro Village potable well (less than 2 m)
  - Minimize the potential to intercept contaminated groundwater from beneath the engineered cap
- Estimated reduction in arsenic loading to the Moira River, as a result of the waste consolidation, capping, and groundwater interception measures, are:
  - 52.1 kg/day (1979)
  - <10 kg/day (since 1983)
  - Approximately less than 1 kg/day (after cleanup to meet the overall closure objective of a 90 percent reduction in arsenic discharge to the Moira River, so as to achieve interim PWQO in the Moira River downstream of the site)
- Implementation of the recommended alternative for the Industrial Area is also expected to provide safe, long-term containment of the Industrial Area wastes, including the low-level radioactive wastes

Mine Area

Key performance indicators for the Mine Area include:

- HLW will be excavated and transferred for consolidation under the engineered cover, eliminating these sources in the Main Mine Area and the Remote Mine Areas
- Waste rock stockpiles and marginally leachable wastes/soils will be capped, minimizing leachate generation
- Increasing pumping at the Tuttle Shaft to year-round pumping will eliminate the artesian discharge of arsenic contaminated groundwater to Moira River
- Cleanup activities and year-round pumping at the Tuttle Shaft (together with the cleanup activities to be undertaken in the Industrial Area) are expected to result in very low arsenic loading to the Moira River (approximately less than 1 kg/day)
- Implementation of the recommended alternative for the Mine Area is also expected to provide safe, long-term containment of the remaining wastes/soils in the Main Mine Area, and includes the removal of a small quantity of low-level radioactive wastes for consolidation with similar wastes in the Industrial Area

Tailings Area

Key performance indicators for the Tailings Area include:

- Engineered cover/hybrid poplar trees will allow less than approximately 10 percent of the annual precipitation to infiltrate to the underlying tailings, thereby minimizing the generation of new contaminated seepage beneath the walls of the tailings dam

- Interceptor ditch will divert upstream, non-impacted surface water from the Tailings Area, further minimizing infiltration of surface water into the tailings
- The above-noted cleanup measures, together with the pumping and treatment of contaminated seepage from beneath the walls of the tailings dam, is expected to eliminate or substantiality minimize the cobalt and copper loading from the Tailings Area to the Moira River
- Implementation of the recommended alternative for the Tailings Area is also expected to provide safe, long-term containment of the tailings, including the radioactive tailings

Young's Creek Area

Key performance indicators for the Young's Creek Area include:

- Removal of the contaminated sediments/soils, including some radioactive sediments that originated from the Tailings Area will address current risks/concerns:
  - Exposure to radiation
  - Elevated human health and ecological risk
  - Potential erosion/transport of contaminated materials downstream during severe storm events
  - Undesirable risk to public and ecological receptors in offsite portion of Young's Creek (offsite portion of Young's Creek is not fenced)
- The secure containment cell is expected to provide safe, long-term storage of these materials, including the radioactive tailings/sediments

Health, Safety, and Environmental Controls

Protection of public health and the environment is of paramount concern throughout and following the physical work proposed for the Deloro Mine Site Cleanup. Public health is viewed to encompass worker health and protection for individuals engaged in the cleanup activities as well as protection for residents near the site. This includes people living in the Village of Deloro and downstream along the Moira River. Environmental protection includes identifying risks related to potential releases during the cleanup whether through liquid releases to the Moira River, spillage of wastes during relocation, or dust/air emissions as a result of physical works at the site. The ICP outlines the provisions that are proposed as part of this comprehensive plan. This includes provisions for containment, monitoring, and mitigation. A number of specific plans and measures are proposed to address various aspects of the identified health, safety, and environmental risks including:

- Site Security and Safety Provisions
- Health and Safety Plans/Monitoring for Worker Protection
- Environmental and Community Health Protection Plan
  - Dust and Air Monitoring
  - Noise Control
  - Surface Water Protection
- Emergency Response and Preparedness Plan
- Transportation and Emergency Response Plan
- Contamination Control and Decontamination Provisions

- Extensive Monitoring Programs for two time frames:
  - Construction Phase
  - OMM Phase

Approval Requirements

The primary regulatory approvals that must be applied for and issued by the appropriate government agencies are summarized below.

As confirmation that the actual cleanup is completed according to the SSRA, a Record of Site Condition (RSC) will be prepared and filed to document the cleanup. The RSC is completed jointly by the proponent, MOE, as well as the consultant overseeing the cleanup. New regulations (O. Reg. 153/04) coming into force on October 1, 2004 will require that an RSC is filed and that a Certificate of Property Use outlining the requirements to meet regulatory requirements is issued.

Other site-wide regulatory approvals that must be applied for and issued will be sought from the following agencies:

- MOE Certificates of Approval (C of As) for sewage and waste disposal; permits to take water; and Part V approval under the Provincial *Environmental Protection Act*
- Conservation Authority regulations: the *Fill, Construction, and Alteration to Waterways Regulation*
- The Ministry of Natural Resources (MNR) is responsible for issuing Work Permits under several different Provincial Acts including the *Forest Fire Prevention Act*, *Lakes and Rivers Improvement Act*, and *Public Lands Act*
- The Department of Fisheries and Oceans (DFO) is responsible for the *Navigable Waters Protection Act* and the *Fisheries Act*
- The Canadian Coast Guard (CCG) will need to be consulted regarding navigable water issues
- Environmental Assessment and Canadian Nuclear Safety Commission (CNSC) Licensing will be required to manage the low-level radioactive and non-radioactive wastes on the site

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed in general accordance with the requirements of the document entitled, *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The Ontario Ministry of Northern Development and Mines (MNDM) has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

Remaining Stage 1 Tasks

The main project phases which must be completed in Stage 1 include public consultation, environmental assessment, engineering, and approvals prior to the start of Stage 2 of the project (tendering and construction). Stage 1 is projected to be completed by mid-2006. Stage 2 construction is anticipated to commence in the 2007 construction season and continue for a minimum of three years.

CH2M HILL

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List of Acronyms

ATP	Arsenic Treatment Plant
C of A	Certificate of Approval
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
COC	Contaminant of Concern
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECHPP	Environmental and Community Health Protection Plan
EIS	Environmental Impact Study
EPA	Environmental Protection Act
GCL	Geosynthetic Clay Liner
GHASP	General Health and Safety Plan
GIWN	Groundwater Interceptor Well Network
GST	Goods and Services Tax
GUCSO	Guideline for Use at Contaminated Sites in Ontario
H&S	Health and Safety
HADD	Harmful Alteration, Disruption, or Destruction
HDPE	High-Density Polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HLW	Highly Leachable Waste
ICP	Integrated Cleanup Plan
LEL	Lowest Effect Level
masl	Metres Above Sea Level
mbgs	Metres Below Ground Surface
MLS	Marginally Leachable Soil
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MRCA	Moira River Conservation Authority
MTC	MOE Technical Committee
NPV	Net Present Value
NSCA	Nuclear Safety and Control Act
NWPA	Navigable Waters Protection Act
OCWA	Ontario Clean Water Agency
OMM	Operation, Maintenance, and Monitoring
OWRA	Ontario Water Resources Act
PC of A	Provisional Certificate of Approval
PLC	Public Liaison Committee
PPE	Personal Protective Equipment
PSW	Provincially Significant Wetland

PTB	Primary Treatment Building
PTTW	Permit to Take Water
PVC	Polyvinyl Chloride
PWQO	Provincial Water Quality Objectives
QC	Quinte Conservation
RA	Responsible Authority
RSC	Record of Site Condition
SDB	Standards Development Branch
SEL	Severe Effect Level
SLERA	Screening Level Ecological Risk Assessment
SPMDD	Standard Proctor Maximum Dry Density
SSRA	Site-Specific Risk Assessment
TERP	Transportation and Emergency Response Plan
TLC	Technical Liaison Committee
USEPA	U.S. Environmental Protection Agency
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WCA	Waste Consolidation Area
WNSL	Waste Nuclear Substance Licence

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Tables

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Figures

1. Introduction

1.1 Background

A brief history of the Deloro Mine Site and the associated environmental issues that arose from more than a century of mining related activities, the need to rehabilitate the site, and the purpose and the organization of this document are provided in this section.

1.1.1 Deloro Mine Site

The Deloro Mine Site is located in Eastern Ontario along the banks of the Moira River (Figure 1-1) east of the Village of Deloro (Figure 1-2). The former refinery/smelter site (Industrial Area) is approximately 25 ha in area and is located adjacent to the west bank of the Moira River. The Tailings Area is located east of the Industrial Area between the east side of the Moira River and the west side of Young's Creek. The entire property, which includes the Industrial Area, Mine Area, Tailings Area, and the onsite portion of Young's Creek, is approximately 202 ha in area (CH2M HILL, February 2002).

Access to the mine site is via Deloro Road, which is accessed from Highway 7, approximately 4 km east of Marmora. The principal population centres in the area are the Village of Deloro (pop. 180), and the Villages of Marmora (pop. 1,700) and Madoc (pop. 1,400), located approximately 5 km southwest and 10 km east of the mine site, respectively.

The Deloro Mine Site began operation as a gold mine in the 1860s and evolved over the next century to mine and refine gold, as well as smelt and refine a number of other elements including arsenic, silver, and cobalt. It was the first plant in the world to produce cobalt commercially and was also a leading producer of stellite, a cobalt-chromium-tungsten alloy. Concentrates from uranium extraction were imported to the site and further processed to extract cobalt. Arsenic-based pesticides were produced from the by-products of smelting operations and continued as a main activity at the site until the market collapsed in the late 1950s.

A century of handling hazardous materials and chemicals has resulted in significant environmental degradation of the Deloro Mine Site. Large quantities of refining slag, mine tailings, calcium arsenate, and arsenical pesticides remained at the site. Fuels, chemicals, and raw materials, such as sulphuric acid, coke, lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate, and fuel oil were handled at the site. Radioactive slag and tailings were produced as a result of the re-refining of by-products from uranium refining.

The Ontario government stepped in to take control of the site in 1979 due to the failure of the owner to control environmental releases. The Ministry of the Environment (MOE) has been in care and control of the site since that time. Several rehabilitation actions have been implemented at the site that have significantly reduced releases from the site. In 1979, the annual average loading of arsenic to the Moira River was 52.1 kg/day. Since the Arsenic Treatment Plant (ATP), located in the Industrial Area of the site, was put into operation in 1983, the arsenic loading to the river has been reduced by more than 80 percent, to an annual average of less than 10 kg/day. However, further work is required to reduce releases

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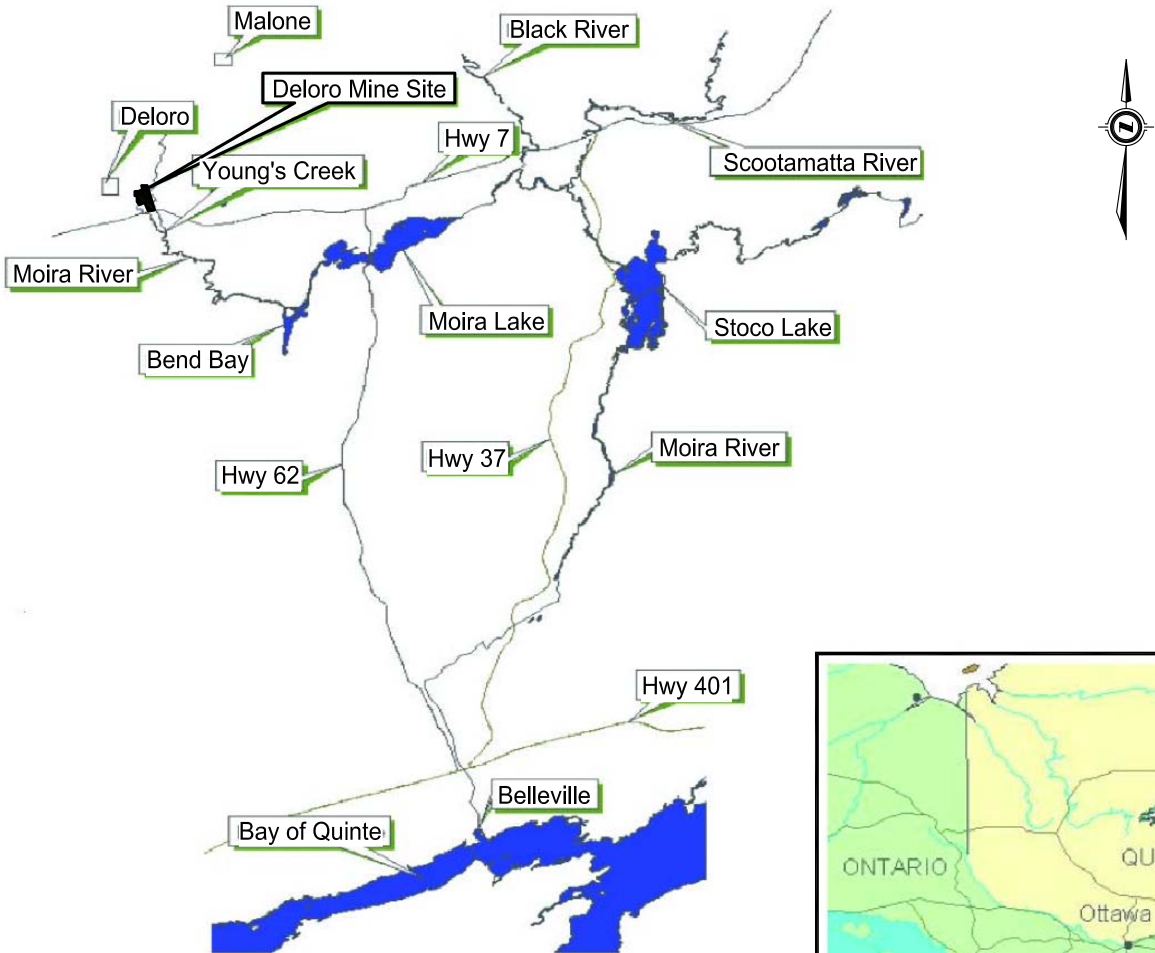

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INTEGRATED CLEANUP PLAN

FIGURE 1-1
SITE LOCATION PLAN

PROJECT No. 119548

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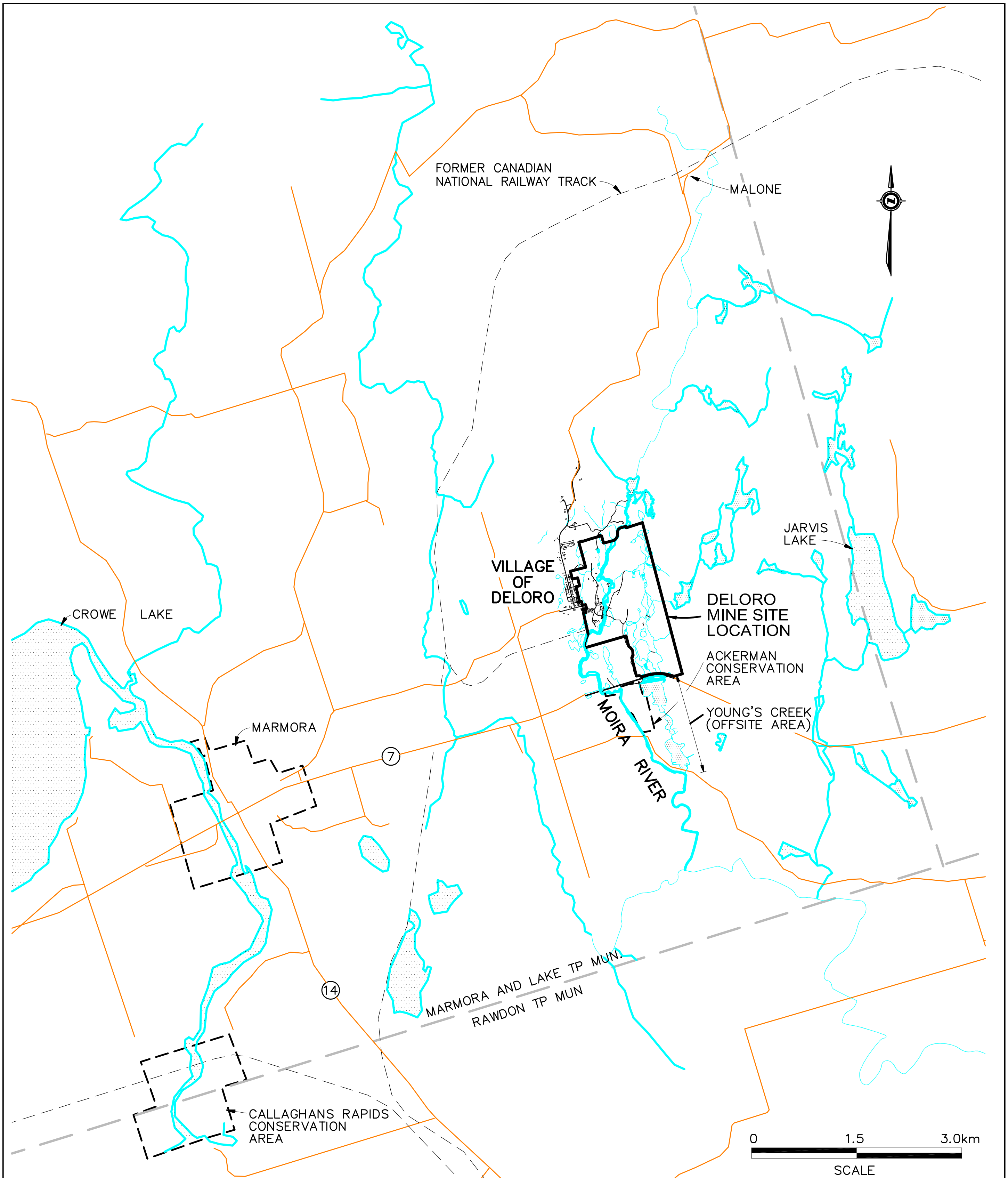

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INTEGRATED CLEANUP PLAN

FIGURE 1-2
DELORO MINE SITE LOCATION

PROJECT No. 119548

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to acceptable levels and to secure the site for the long-term. CH2M HILL Canada Limited (CH2M HILL) was retained to provide consulting engineering and project management services for the Deloro Mine Site Cleanup.

1.1.2 Rehabilitation Alternatives

CH2M HILL was retained by the MOE to develop and implement a comprehensive rehabilitation program for the closure of this former mine site. As part of this comprehensive rehabilitation program, CH2M HILL evaluated a broad range of rehabilitation alternatives and identified a recommended alternative for further development for each of the four areas within the mine site's footprint, as shown in Figure 1-3. The limits of these four areas have been developed based on historical land use and waste disposal practices. The four areas are the:

- Industrial Area, where smelting and refining of various ores were carried out
- Mine Areas, on both the east and west sides of the Moira River
- Tailings Area, where by-products of the production phase were stored
- Young's Creek Area, which has been impacted from historical releases from the Tailings Area

The rehabilitation alternatives reports prepared by CH2M HILL are as follows:

- *Deloro Mine Site Cleanup – Industrial Area Rehabilitation Alternatives* (December 2003)
- *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives* (October 2003b)
- *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives* (October 2003a)
- *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (May 2003a)

1.1.3 Development of the Recommended Alternative

Closure plans were developed to describe the recommended alternative for each area of the site. The Closure Plans will be used as a basis for public consultation and regulatory approvals. The Closure Plans for each of the four areas of the site are based on the site-wide closure objectives identified in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998), including area-specific closure objectives (see Section 1.2) and the recommended rehabilitation alternatives developed for each area. The recommended alternatives are further developed in the four closure plans as follows:

- *Deloro Mine Site Cleanup – Industrial Area Closure Plan*
- *Deloro Mine Site Cleanup – Mine Area Closure Plan*
- *Deloro Mine Site Cleanup – Tailings Area Closure Plan*
- *Deloro Mine Site Cleanup – Young's Creek Area Closure Plan*

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed to satisfy, in general, the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). This document includes provisions for the protection of the environment.

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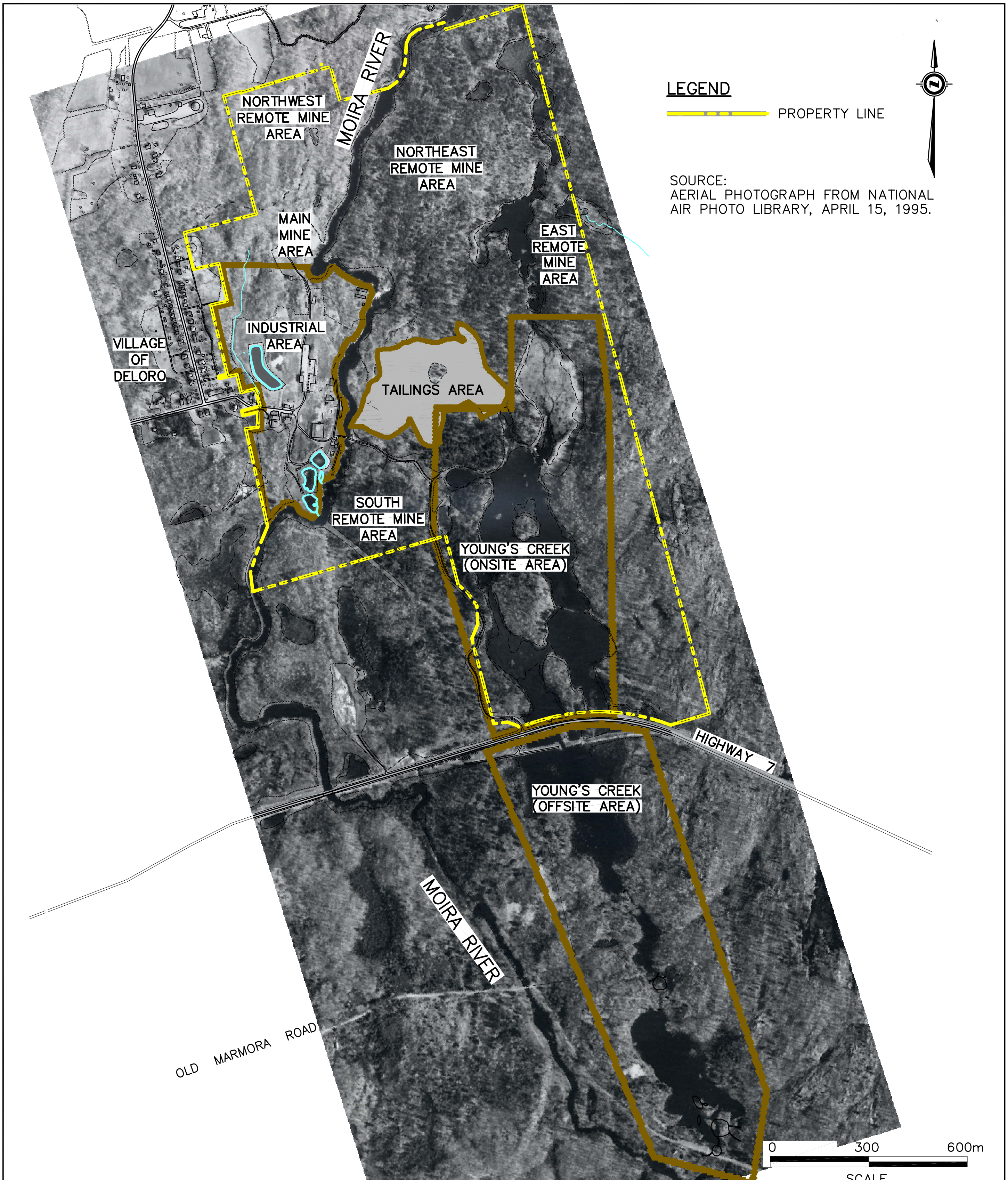

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INTEGRATED CLEANUP PLAN

FIGURE 1-3: DELORO MINE/REFINERY SITE SHOWING THE INDUSTRIAL, MINE, TAILINGS AND YOUNG'S CREEK AREAS - DELORO, ONTARIO

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The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment (SSRA) and groundwater modelling studies. Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

1.1.4 Purpose of this Integrated Cleanup Plan

This report is an Integrated Cleanup Plan (ICP) that assimilates and integrates the four area-based Closure Plans to provide a comprehensive summary of the cleanup efforts planned for the entire Deloro Mine Site (and related offsite areas). In addition to summarizing the area-based plans, the ICP was developed to consider logistics and capitalize on synergies between the various plans. The ICP includes optimization and prioritization of remedial actions across the affected areas.

1.1.5 Organization of Report

This report consists of nine sections, including the introduction. Section 2 summarizes the findings of the alternatives considered and the recommended rehabilitation strategy for each area. Sequencing and optimization of the cleanup is presented in Section 3, including a multi-year schedule and opportunities to reduce the duration of physical construction. Section 4 provides the annual plans for the cleanup, illustrating the year by year progress and the final conditions once all rehabilitation is complete. A composite cost estimate and cash flow projection is provided in Section 5. Health, safety, and environmental controls are outlined in Section 6. Known and anticipated approval requirements are outlined in Section 7. The path forward to complete Stage 1 activities leading to the start of construction is described in Section 8, and Section 9 lists the references used in the preparation of this report.

1.2 Cleanup Approach and Criteria

Extensive previous investigation and evaluation has been undertaken at the Deloro Mine Site. Based on strategic decisions made by the MOE in the early 1990s, the most viable solutions for the management of residuals at the Deloro Mine Site involve onsite management through isolation and containment techniques in which mitigative action is directed at risk reduction. In this approach, risks to both human health and the environment are considered under both the current and reasonably expected future land uses. Remedial action is then undertaken to reduce any unacceptable risks to humans or the environment. This approach has been recognized as an option in the MOE's *Guideline for Use at Contaminated Sites in Ontario* (GUCSO) (MOE, 1997), in which it is referred to as the Site-Specific Risk Assessment (SSRA). The SSRA is the approach selected by the MOE as the proponent for the Deloro Mine Site rehabilitation.

The strategic direction for site cleanup, involving the onsite management of wastes through isolation and containment methods as primary remediation techniques, is described in the report entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998). This translates into the following project objective:

> *To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.*

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site to mitigate, within reason, any unacceptable impacts on human health or the environment. As part of this overall objective, site-wide closure objectives have been developed as follows:

1. Reducing the loading of arsenic and other contaminants to the Moira River
2. Complying with appropriate regulations and policy
3. Satisfying the general intent of the *Mining Act* and related draft regulations
4. Reducing/controlling impact/risk to acceptable levels
5. Demolishing unneeded buildings to ground level
6. Prioritizing remedial action implementation according to risk reduction
7. Minimizing perpetual operation and maintenance
8. Restoring the site to reflect its natural surroundings
9. Securing the site for the indefinite future
10. Managing the wastes over the smallest possible area

The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to achieve current/interim Provincial Water Quality Objectives (PWQO) at the intersection of the Moira River and Highway 7 (CG&S, October 1998). Monitoring will be completed to assess actual performance. Contingency measures have been incorporated as part of the recommended alternative for each area of the site and are further developed as part of the Closure Plans. These site-wide closure objectives were further refined into area-specific closure objectives for each area of the site (Table 1.1).

TABLE 1.1
CLOSURE OBJECTIVES FOR EACH AREA OF THE DELORO MINE SITE

Industrial Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Remove wastes and residues from the area impacted by the design flood event
4. Provide flood protection for wastes/residues outside the design flood event
5. Manage radioactive materials to reduce radiation at ground surface to background levels
6. Cover and grade wastes/residues with material suitable to minimize infiltration
7. Isolate wastes/residues to eliminate, to the extent possible, releases to the environment according to the site-wide priorities
8. Co-manage wastes of similar risk (i.e. consolidate higher risk wastes and provide a suitably high degree of containment)
9. Design life for engineered facilities consistent with accepted design practice
Mine Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Consolidate contaminated (heavily impacted) materials into limited areas of the site where appropriate
4. Restore closed mine areas to blend in with native conditions (current natural surroundings)

TABLE 1.1
CLOSURE OBJECTIVES FOR EACH AREA OF THE DELORO MINE SITE

Tailings Area

1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to eliminate exposed wastes at ground surface
4. Manage contaminated groundwater/seepage/runoff
5. Promote revegetation of the area to match native conditions (i.e. to match current natural surroundings)
6. Contain tailings for the long-term, consistent with accepted design practice
7. Provide assurance of dam stability through testing and, if required, dam stabilization

Young's Creek Area

1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to reduce potential exposure of contaminated sediments to human and environmental receptors
4. Implement measures to prevent increased contaminant loading to the Moira River due to re-suspension of residual contaminated material
5. Restore area to match surrounding conditions and in accordance with Ministry of Natural Resources (MNR) policies and requirements
6. Design life for engineered facilities consistent with accepted design practices

1.3 Related Reports and Studies

A list of the reports and other documents referenced in this document is provided in Section 9. Related reports and studies are on public record and available for review from the Kingston MOE office. The primary documents used in the developing the ICP are the Alternatives Reports and Closure Plans for each of the four areas listed above. These documents will be available for downloading from the MOE Web site at http://www.ene.gov.on.ca/envision/deloro/index.htm in the fall of 2004.

1.4 Alternatives Reports

The Deloro Mine Site Cleanup is being conducted according to the GUCSO (MOE, 1997) following the SSRA option. (As of October 1, 2004, the guideline will be incorporated into regulation under O. Reg. 153/04.) The approach has been adapted or enhanced to meet other regulatory or best management practices including the *Canadian Environmental Assessment Act* (CEAA).

A process was developed to generate potential remedial alternatives and select a recommended alternative for each of the four areas of the Deloro Mine Site. This process is described in the Alternatives Report for each area. Initially, conceptual remediation methods that could have addressed some or all of the issues were evaluated with a screening process to identify which had the greatest potential to address the issues at the site, either alone or in combination with other methods. Improbable methods that did not have significant potential to contribute to a viable solution were eliminated early in the process. This resulted in a number of primary remediation methods that were retained for further evaluation.

The primary methods and enhancing features were combined to create the comprehensive remediation alternatives addressing all of the environmental issues in each area. The full

range of comprehensive remediation alternatives considered in each area of the site is provided in Table 1.2.

TABLE 1.2
COMPREHENSIVE REMEDIATION ALTERNATIVES CONSIDERED FOR EACH AREA OF THE SITE

Industrial Area

1. Consolidate and cover
2. Consolidate and cover – Ground/surface water flow diversion
3. Consolidate and cover – Ground/surface water flow diversion, selected solidification
4. Consolidate and cover – Ground/surface water flow diversion, selected offsite disposal
5. Consolidate and cover – Ground/surface water flow diversion, enhanced groundwater collection
6. Consolidate and cover – Ground/surface water flow diversion, selected solidification, enhanced groundwater collection
7. Consolidate and cover – Ground/surface water flow diversion, selected offsite disposal, enhanced groundwater collection
8. Cap/cover in place
9. Cap/cover in place – Ground/surface water flow diversion
10. Cap/cover in place – Ground/surface water flow diversion, selected solidification
11. Cap/cover in place – Ground/surface water flow diversion, selected offsite disposal
12. Cap/cover in place – Ground/surface water flow diversion, enhanced groundwater collection
13. Cap/cover in place – Ground/surface water flow diversion, selected solidification, enhanced groundwater collection
14. Cap/cover in place – Ground/surface water flow diversion, selected offsite disposal, enhanced groundwater collection
15. Full encapsulation
16. Full encapsulation – Enhanced groundwater collection

Mine Area

Main Mine Area

1. Increase pumping from Tuttle Shaft; remove highly leachable waste (HLW) and fill excavation; cover entire affected soil/concentrated waste area with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate
2. Increase pumping from Tuttle Shaft; remove HLW and fill excavation; cover waste rock with geofabric, clay, topsoil, and then vegetate; cover only heavily impacted soil/concentrated waste areas with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate
3. Increase pumping from Tuttle Shaft; cover waste rock with geofabric, clay, topsoil, and then vegetate; excavate and dispose of heavily impacted soil and HLW; cover excavated area with clay, topsoil, and then vegetate

Remote Mine Area

1. Cover waste rock with geofabric, clay, topsoil, and then vegetate

Tailings Area

1. Cover the surface of the area with soil and vegetation
2. Cover the surface of the area with soil and vegetation, and divert surface runoff away from the area
3. Cover the surface of the area with soil and vegetation, and collect and treat contaminated seepage and groundwater using a natural treatment system
4. Cover the surface of the area with soil and vegetation, and collect and treat contaminated seepage and groundwater at the existing onsite ATP
5. Cover the surface of the area with soil and vegetation, divert surface runoff away from the area, and collect and treat contaminated seepage and groundwater using a natural treatment system
6. Cover the surface of the area with soil and vegetation, divert surface runoff away from the area, and collect and treat contaminated seepage and groundwater at the existing onsite ATP

Young's Creek Area

1. Shallow excavation, disposal onsite, creek rehabilitation with optional enhancing features:
   - In-place capping
   - Flow regulation
2. Deep excavation, disposal onsite, creek rehabilitation

These comprehensive remediation alternatives were subsequently evaluated in a two-step process. The screening level evaluation again served to eliminate comprehensive remediation alternatives (as opposed to conceptual remediation methods that had been previously screened) that were unlikely to meet all of the remediation needs for the area. This second level of screening led to a short list of comprehensive remediation alternatives that were the subject of a more detailed evaluation. The detailed evaluation led to the identification of a recommended remediation alternative, which was developed further in the Closure Plan for each area.

1.5 Summary of the Recommended Alternatives

The recommended rehabilitation alternative for each area of the site is identified in Table 1.3 and outlined further in Section 2.

TABLE 1.3
RECOMMENDED REHABILITATION ALTERNATIVE FOR EACH AREA

Industrial Area Consolidate and cover wastes with an engineered cover augmented with groundwater and surface water flow diversion to enhance the existing collection/treatment system
Mine Area Relocation/consolidation of HLW to the Industrial Area, placement of a soil cover in the remaining areas and treatment of groundwater from the Tuttle Shaft
Tailings Area Cover tailings with an engineered soil cover combined with collection/treatment of groundwater and upstream surface water flow diversion
Young's Creek Area Full depth excavation of onsite residues, shallow depth excavation of offsite residues, residue disposal in a new onsite engineered containment facility followed by creek rehabilitation

1.6 Closure Plan Contents

The Closure Plans referenced in Section 1.1.3 contain information pertaining to the design and implementation of the recommended alternatives, including:

- Site security and safety
- Building demolition
- Waste isolation and containment
- Water management
- Mine workings, crown pillars, and surface workings
- Work package identification and sequencing
- Anticipated construction impacts and mitigation measures
- Final site grading
- Site rehabilitation and revegetation
- Implementation schedule
- Cost opinion of work packages associated with each closure plan
- Health hazard assessment
- Environmental and community health protection plan
- Operation and maintenance requirements
- Monitoring programs
- Expected post-closure conditions and uses

2. Recommended Closure Plans and Key Performance Indicators

The following elements of the recommended Closure Plan for each key area of the Deloro Mine Site are presented in Sections 2.1 through 2.4:

- Overview of Recommended Alternative
- Cleanup Approach and Extent
- Summary of Work Packages
- Design Description (includes estimated waste volumes)
- Implementation Schedule

In the case of the Industrial Area, the current and estimated future flow volumes to the ATP are also examined.

As noted in Section 1, the Closure Plans also contain additional details pertaining to the design, cost opinion, implementation of the recommended alternatives, and related topics.

The ability of the design components of each recommended alternative to achieve or support the closure objectives (presented in Section 1.2) is examined in Section 2.5 in terms of key performance indicators.

2.1 Industrial Area Closure Plan

2.1.1 Overview of Recommended Alternative

The recommended alternative for the Industrial Area Closure Plan, consistent with the closure objectives, involves consolidating highly leachable and hazardous wastes under an engineered cover designed to minimize infiltration. Unaffected, clean groundwater will be diverted away from the wastes under the engineered cover by a passive groundwater interceptor well network (GIWN) located near the western boundary of the Industrial Area.

A simple earth (clay) cap will cover the remainder of the Industrial Area to minimize infiltration, where less leachable wastes, including slag material, construction debris, and impacted soil are present. The simple earth (clay) cap is also required to cover the remainder of the Industrial Area (except for bedrock outcrop areas) to ensure there are no unacceptable risks to human health and ecological receptors. Other cleanup work identified in the Industrial Area Closure Plan includes demolition of buildings and tanks, consolidation of existing ruins, and reconstruction of the contaminated western bank of the Moira River.

Extensive grading and interceptor ditches will be constructed to drain or divert surface water from the engineered cover and the simple earth (clay) cap.

The existing groundwater collection/treatment system will continue to operate for the foreseeable future.

The MOE, in cooperation with the Municipality of Marmora and Lake, will continue with its procedure for managing excess soil from the village of Deloro to ensure its proper disposal.

Once the Deloro Mine Site cleanup is completed, there will no longer be an area at the site to receive the excess soil. Options for future disposal of the excess soil are being considered. One option is for the MOE to continue to arrange for pickup of the excess soil and to take it to an approved landfill site for disposal versus to the Deloro Mine Site.

2.1.2 Cleanup Approach and Extent

Onsite Management and Risk Reduction

As noted in Section 1.2, the most viable solution that has been developed for the management of wastes at the Deloro Mine Site involves risk reduction and onsite management through isolation and containment techniques.

In support of the rehabilitation program and as part of the development of the final cleanup plan, CH2M HILL completed a draft screening level ecological risk assessment (SLERA) and a draft human health risk assessment (HHRA) to assess the risks associated with the Deloro Mine Site and Young's Creek offsite area following rehabilitation. The risk assessment was completed for the entire site, including the four main areas. This section presents a summary of the findings of the Deloro Mine Site SSRA and Young's Creek offsite area SSRA, respectively. Complete details concerning the SLERA and HHRA are provided in the following reports:

- *Deloro Mine Site Cleanup – Deloro Mine Site Site-Specific Risk Assessment*, *Draft Report* (CH2M HILL, May 2003b)
- *Deloro Mine Site Cleanup – Offsite Young's Creek Site-Specific Risk Assessment, Draft Report* (CH2M HILL, May 2003c)

The extent of isolation and containment of wastes, following waste excavation and consolidation (in some cases), at the Deloro Mine Site is governed by the need to ensure that there are no unacceptable risks remaining to human health and ecological receptors for reasonably expected future land uses. In the case of the Industrial Area, capping is required across the entire Industrial Area, using either the engineered cover or the simple earth (clay) cap, as recommended by the draft SSRA report for the Deloro Mine Site.

In order to prevent exposure to burrowing animals as part of the SLERA (as well as due to the potential risk of transmigration of contaminants via tree roots), the thickness of any capped areas was increased to be at least 1.5 m[1].

The extent of cleanup defined for the Mine Area and Tailings Area is based on the same rationale used in the Industrial Area. The cleanup approach and extent for the Young's Creek Area is also based on risk reduction and is further examined in Section 2.4.2.

Supplementary Risk Assessment

The draft SSRA documented the presence of metal contaminant-related issues within the Deloro mine onsite area and Young's Creek offsite area under the post-closure condition for the recommended rehabilitation alternative. While the SSRA results did not show unacceptable risk under most conditions, it indicated that there were potential risks to plants and animals residing within these areas, as well as to humans spending time on the

[1] With exception, the cap thickness over slag and waste rock in the Industrial Area and Mine Area, respectively, was set at 0.65 m since these materials are not considered to be bioavailable. (In the case of radioactive slag, the draft SSRA indicates that a minimum 0.45 m cap [i.e. consistent with the planned use of a 0.65 m cap] over radioactive constituents at the site will reduce radiation fields to background levels.)

respective properties, in some circumstances. The extensive characterization work at the site has focused on the areas requiring remediation, with less effort directed to areas that will remain post-closure. As a result, the data used to define the nature and extent of post-closure contamination and subsequent risk, or to establish acceptable risk-based cleanup levels, is being augmented through further investigative work. Further, the conclusions for potential risks to ecological receptors/valued ecosystem components (VECs) were primarily based on published reference values consistent with a screening level risk assessment (e.g. GUCSO). These values are not specific to this site, the activities that have taken place, or the types of contaminants present. In order to confirm that the recommended alternatives are appropriate and that remediation is not required over a broader area of the site (beyond the areas identified below), additional site information is being collected and further risk evaluation is underway.

The results of the supplementary site information and risk assessment will be used to fill in the data gaps, increase the confidence in the risk evaluation, and update the draft results of the HHRA and SLERA for both the Deloro Mine Site SSRA report and Young's Creek Offsite SSRA report. The revised reports will be prepared in a format that is suitable for submission to the Standards Development Branch (SDB) of the MOE for their review following the additional work. If necessary, the Closure Plans will be revised to address additional areas of the site that need to be capped or excavated.

The following briefly lists the studies that are ongoing to verify and substantiate the conclusions of the SLERA and the HHRA:

- Additional chemical characterization of onsite soil, sediment, and surface water
- Collection of biota co-located with soil, sediment, and surface water samples for evaluation of site-specific bioaccumulation
- Biological and physical surveys within the Young's Creek onsite area
- Toxicity testing of the Young's Creek onsite area
- Bioavailability of Contaminants of Concern (COCs) in soil, sediment, and surface water

2.1.3 Summary of Work Packages

The work packages associated with the recommended alternative for the Industrial Area are listed in Table 2.1

TABLE 2.1
IDENTIFICATION OF INDUSTRIAL AREA WORK PACKAGES

Package ID	Industrial Area Work Package Description
IA-WP#1	Site Preparation
IA-WP#2	Demolition of Buildings/Tanks and Resizing/Consolidation of Ruins
IA-WP#3	Riverbank Reconstruction
IA-WP#4	Consolidation of Selected Wastes
IA-WP#5	Simple Earth (Clay) Cap Placement
IA-WP#6	Engineered Cover Placement
IA-WP#7	Installation of Groundwater Interceptor Well Network
IA-WP#8	Site Revegetation

The Industrial Area work packages have been subdivided into tasks and subtasks and reorganized as necessary in the implementation schedule provided in Section 2.1.5.

2.1.4 Design Description

IA-WP#1: Site Preparation

Site preparation activities will include the establishment of controls protective to the environment and human health, mobilization of equipment (excavators, trucks, site trailers, and other equipment), construction of access roads, clearing and grubbing of the land, and establishment of temporary services such as site trailers, utilities, and a decontamination pad.

As the rehabilitation program will span several years, certain site preparation tasks will be duplicated every year, including the mobilization and demobilization of equipment and trailers. Clearing and grubbing of the land will be conducted on areas that are to be affected by construction activities that year. Trees may be mulched and reused on the site as cover.

IA-WP#2: Demolition of Buildings/Tanks and Resizing/Consolidation of Ruins

All above-ground structures at the Deloro Mine Site will be demolished to ground level as part of the Deloro Mine Site Cleanup, with the exception of the operating ATP and parking garage. The powerhouse building, concrete trestle piers of the former primary treatment building (PTB), and portions of the castings building walls might be preserved as part of a heritage plan for the site.

Most of the former buildings have been demolished to some extent or are in various states of ruin, however, the remaining buildings are currently unused and pose potential safety hazards.

Demolition materials that are uncontaminated could potentially be used for erosion protection as part of the reconstruction of the Moira River bank.

Contaminated demolition materials will be consolidated and managed along with the impacted fill materials. To ensure that there is no low-level radioactive contamination of building materials, specified buildings (in which low-level radioactive materials were handled) will be surveyed for radioactivity prior to demolition. Those portions found to contain low-level radioactive contamination will be moved into a waste consolidation area (WCA) to be capped with an engineered cover. In addition to the buildings and infrastructure ruins, there is a large amount of rubble and waste spread in small piles about the Industrial Area, which will be collected to improve the general order of the site. All of the demolition materials will be reduced in size, wherever possible, to improve the compaction qualities of the material. Some of the structures, such as the castings building, contain variable quantities of waste material, which will require proper handling and disposal.

Non-contaminated wood waste that is not suitable for onsite consolidation beneath the engineered cover will be reduced using a chipper or tub grinder. The resulting product will be used as a conditioner in the topsoil and simple earth (clay) cap, or consolidated and composted in a suitable area onsite.

The buildings that will require demolition, and the building ruins that will require resizing and consolidation, are listed below. Structures with potential low-level radioactive contamination are identified with an asterisk.

A. Demolition of Buildings and Tanks:

- Castings building*
- Primary treatment building
- Powerhouse
- Three storage tanks

B. Resizing and Consolidation of Building Ruins:

- Cobalt oxide plant ruins*
- Cobalt packer house and plant dry building ruins
- Arsenic packing shed ruins
- Sludge lagoon ruins
- Boarding houses, hub, and kitchen ruins
- Lab building ruins
- Old treatment plant ruins

The Industrial Area Closure Plan contains additional information on the demolition work required at the above structures, including the locations of the buildings, tanks, and building ruins.

IA-WP#3: Riverbank Reconstruction

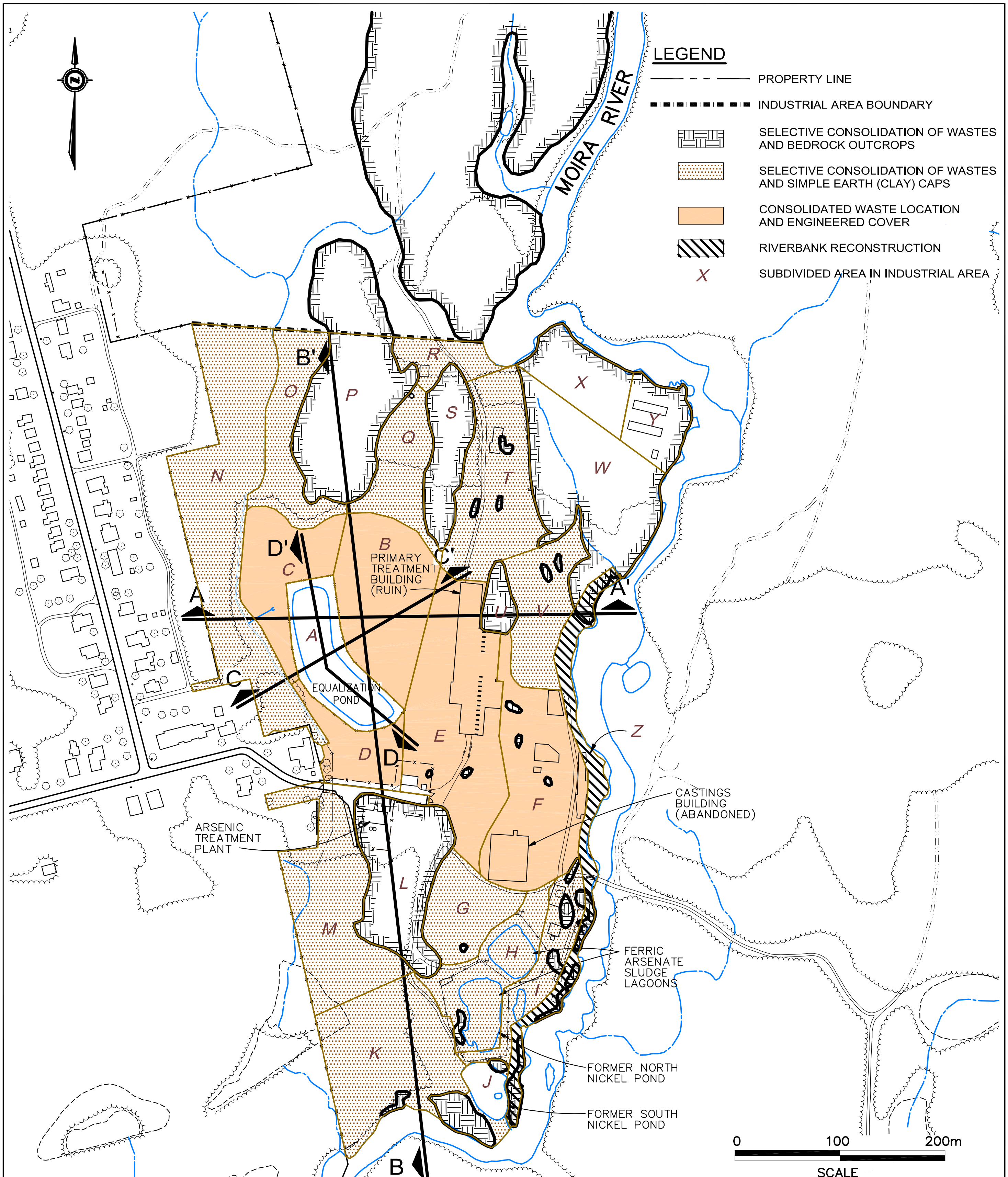
Riverbank and Water Courses. Approximately 620 m of the west bank of the Moira River, adjacent the Industrial Area, will need to be remediated and reconstructed. This section of the west bank contains contaminated material as described in the report entitled, *Deloro Mine Rehabilitation Project – Riverbank Reconstruction Alternatives for the Industrial Area, Final Report* (CH2M HILL, March 2002b). The riverbank to be reconstructed is identified as Area Z in Figure 2-1, relative to the engineered cover and simple earth (clay) caps. The existing site grading and approximate surface water runoff flowpaths under pre-closure conditions for the Industrial Area are shown in Figure 2-1A. The approximate surface water runoff flowpaths under post-closure conditions for the Industrial Area are shown in Figure 2-1B. A cross-section of the riverbank following reconstruction is provided in Figure 2-2.

Existing Riverbank Conditions. The 620-m section is bounded by a bedrock outcrop at both ends allowing for a clear start and end point to the reconstruction of the riverbank. The existing bank slopes vary from fairly gentle slopes, at approximately 3:1, to steep slopes, at 1:1 or near vertical.

In the most northern portion of the proposed reconstruction area, there is an underground concrete cut-off wall with groundwater collection pumps (PS#1 and PS#2) that convey arsenic-bearing groundwater through the water collection system.

The overburden stratigraphy, assessed from boreholes located along the riverbank, consists mainly of an upper layer of slag or brick fill underlain by a silty clay or sandy silt. In borehole GA15, adjacent to the west bank in the central part of the Industrial Area, a material suspected of being calcium arsenate was observed from 1.3-m below grade to bedrock at 2.8 m. The bank material at the toe of the slope consists mainly of local cobble and stone in a range of sizes that provide adequate erosion protection.

23/AUG/2004



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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-1: LOCATION OF CONSOLIDATED WASTES, ENGINEERED COVER, SIMPLE EARTH (CLAY) CAPS AND RECONSTRUCTED RIVERBANK

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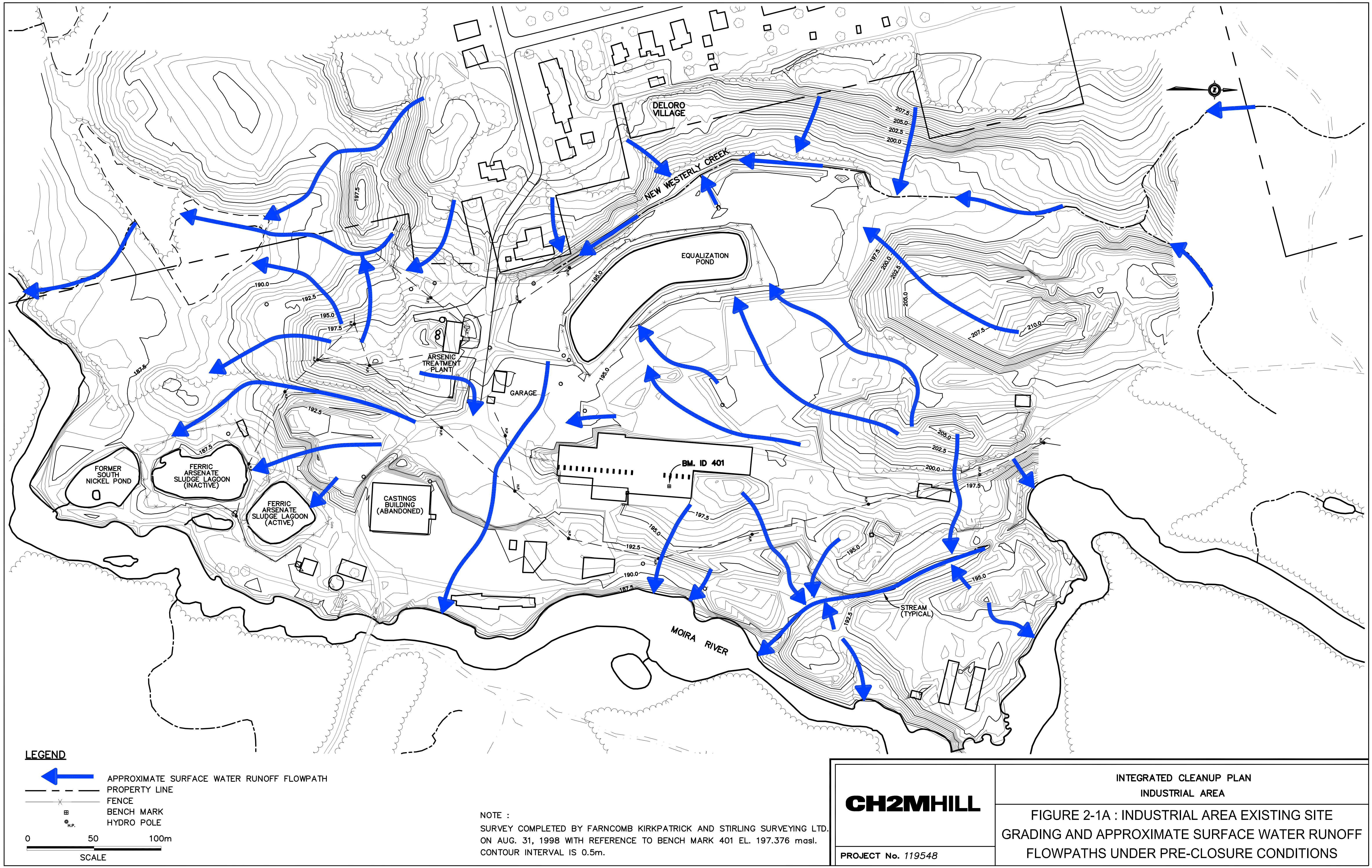

NOTE :
SURVEY COMPLETED BY FARNCOMB KIRKPATRICK AND STIRLING SURVEYING LTD. ON AUG. 31, 1998 WITH REFERENCE TO BENCH MARK 401 EL. 197.376 masl. CONTOUR INTERVAL IS 0.5m.

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-1A : INDUSTRIAL AREA EXISTING SITE GRADING AND APPROXIMATE SURFACE WATER RUNOFF FLOWPATHS UNDER PRE-CLOSURE CONDITIONS

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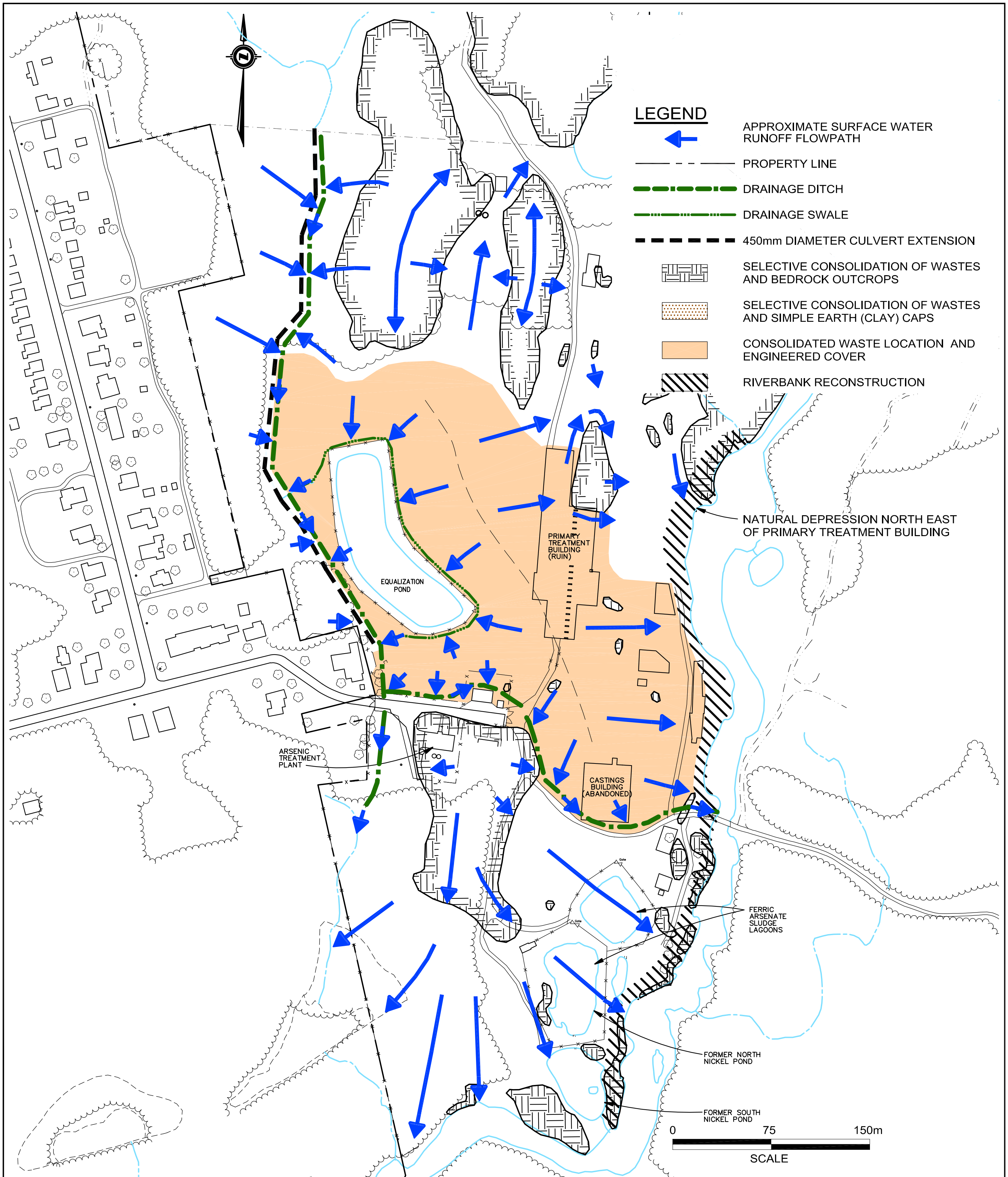

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-1B INDUSTRIAL AREA APPROXIMATE SURFACE WATER RUNOFF FLOWPATHS UNDER POST-CLOSURE CONDITIONS

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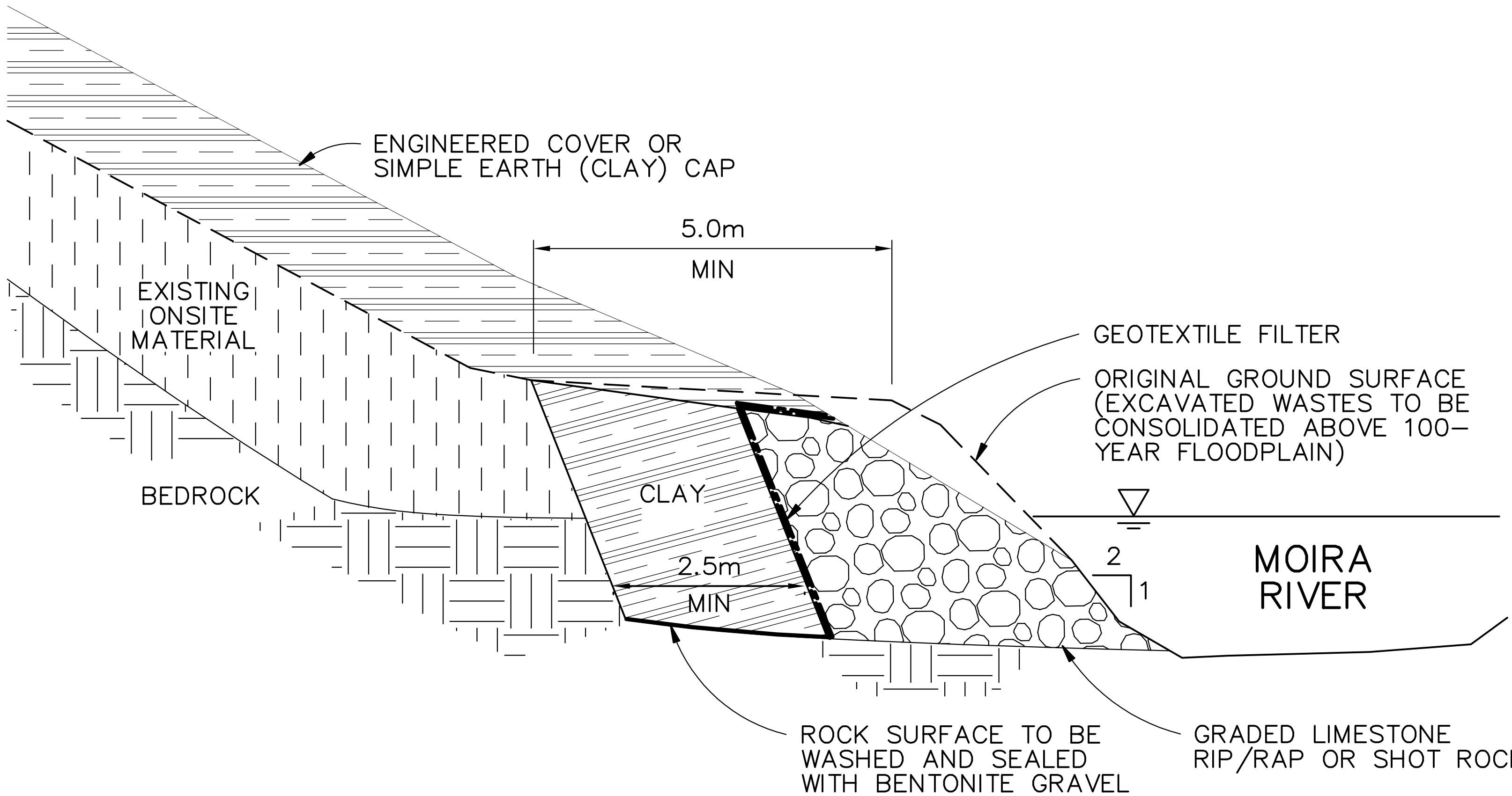

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

PROJECT No. 119548

FIGURE 2-2
RIVERBANK RECONSTRUCTION
TYPICAL CROSS-SECTION

The vegetation along the west bank is sparse and discontinuous along the entire length of the proposed reconstruction. The vegetation is mainly composed of goldenrod, which is common in the surrounding area. Other common weeds are sparsely located along the bank. The vegetation is stressed from the poor growing conditions. The upper bank along the section of the river designated for reconstruction is, for the most part, lightly vegetated with local grasses and shrubs, which provide additional erosion protection to the top of the bank during flood flows.

The habitat character in the area of proposed riverbank reconstruction generally contains sparse riparian cover, but has extensive in-stream cover consisting of boulder and cobble substrates at riffle areas downstream of the mine site bridge crossing, and deep pools and a small embayment upstream of the mine site bridge crossing.

While there is productive in-stream fish habitat in the Moira River adjacent sections of proposed riverbank reconstruction, the history of past industrial disturbance and ongoing contaminant impacts to the Moira River have diminished the quality of the riparian and in-stream aquatic habitat. The potential long-term benefits of the rehabilitation program to minimize or eliminate all impacts and improve the site through cleanup, restoration, and enhancement measures should provide a net positive enhancement to the productive capacity of fish habitat.

Excavation of Contaminated Materials. The streambank reconstruction methods will maintain the configuration of the stream as closely as possible to existing conditions of bank height, bank slope, and available floodplain. There is approximately 10,800 m^3 of waste soil that will be excavated from the riverbank and consolidated. The contaminated material comprising the existing bank will be removed using standard techniques to minimize sediment suspension and transport. It will be stored onsite in Area B, graded, covered with a 50-cm clay layer, and eventually covered with the entire treed engineered cover. Material will be removed to a minimum 5 m distance from the existing riverbank. Removal of this material will provide for adequate contaminant removal and allow subsequent bank reconstruction. This will ensure the stability of the reconstructed bank and the protection of the compacted clay berm adjacent to the contaminated waste material which will be left in place (CH2M HILL, March 2002b).

River Diversion. During the construction period, the Deloro dam or other flow diversion measures will be used to reduce the flow in the river to a level that will expose all bank materials slated for removal. If required, additional diversion capabilities to reduce flow volume may include pumping water from immediately below the falls to downstream of the construction area.

Streambed Protection, Erosion, and Sediment Controls. Consideration will be given to construction methods that minimize the impact on the existing streambed. No heavy equipment will work in or use the streambed for access during construction. Sediment and erosion protection procedures will be undertaken during all phases of the construction to ensure adequate protection of the stream habitat. Measures will be implemented to prevent sediment material from entering the stream or being deposited in the streambed during the actual material removal process. Erosion protection will be provided on the construction site to prevent significant runoff of sediment material during construction. This erosion protection will consist of silt curtains and straw bale dams. Details of the onsite erosion protection plan will be documented in the contract specifications prior to construction.

Preliminary Reconstruction Design. The basic reconstruction of the streambank will be carried out using a rip/rap design. The rip/rap, which will be used to construct the streambank, will be comprised of local quarried shotrock or local graded limestone material with an average diameter of 200 cm or greater. The range of acceptable stone size for the reconstruction bank material will be a minimum diameter of 150 cm to a maximum diameter of 250 cm. The average diameter for the rip/rap stone was selected based on erosion protection required for the mean stream velocity occurring during the 100-year storm event of approximately 3 metres per second.

This recommended primary cover layer of rip/rap stone will be set on a maximum of a 2:1 slope with a minimum thickness of 1 m, selected as a measure of protection for the compacted clay berm. The actual thickness of the primary cover layer of rip/rap will in most instances exceed the minimum thickness of 1 m due to the amount of contaminated material to be removed and subsequently required to be replaced to maintain the contours of the pre-existing streambank.

The 2:1 slope will be maintained, at a minimum, until the bank's full height elevation is reached. Where possible, the surveyed elevation of the original streambank should be used to determine the appropriate elevation of the reconstructed top of the bank. The minimum elevation of the primary 2:1 rip/rap cover layer at the streambank, which corresponds approximately with the bank full height, is 190 metres above sea level (masl).

IA-WP#4: Consolidation of Selected Wastes

The objectives of waste consolidation are to reduce the footprint of highly leachable wastes (HLW) and significantly reduce the leachate generating potential of the wastes to groundwater and surface water.

The Industrial Area covers approximately 244,690 m^2 (approximately 25 ha) of land and for the purposes of this Closure Plan has been divided into five distinct regions: the Equalization Pond (Area A), the Waste Consolidation Area (Areas B to F), the South Industrial Area (Areas G to M), the North Industrial Area (Areas N to Y), and the Riverbank Reconstruction Area (Area Z). Areas A to Z are identified in Figure 2-1.

It has been estimated that the Industrial Area contains approximately 460,000 m^3 of non-contaminated and contaminated soil (fill and overburden) above the bedrock. For the purposes of this Closure Plan, it has been conservatively assumed that all the soil above the bedrock in the Industrial Area is at least partially contaminated.

A waste classification study (Golder, July 1988) on various wastes at the site (e.g. gold tailings, red mud, calcium arsenite, ferric arsenate sludge) indicated that there was little correlation between arsenic concentration in soil and the leachate toxicity of the soil. The lowest arsenic concentration of the various non-leachate toxic wastes analyzed was 4,400 parts per million (ppm). Therefore, CH2M HILL has conservatively designated HLW as wastes with arsenic concentrations exceeding 4,000 ppm, and marginally leachable soil (MLS) as wastes with arsenic concentrations less than 4,000 ppm. This conservative assumption is further supported by samples analyzed for arsenic and leachate toxicity on the Ackerman Conservation Area (Golder, May 1995).

The contaminated soil overburden and fill has been categorized as either HLW requiring consolidation under the engineered cover or MLS requiring a simple earth (clay) cap. The exception is the slag on the site, which was determined to be low-level radioactive in parts

and contains a non-leachable, non-bioavailable form of arsenic (unless mixed in a matrix of soil contaminated with arsenic). Therefore, the slag will be handled in a different manner than HLW and MLS.

The Industrial Area contains approximately 261,200 m^3 of HLW, approximately 4,000 m^3 of demolition/ruin rubble, approximately 39,426 m^3 of slag, and 907 m^3 of low-level radioactive slag mixed with potentially highly leachable soil transferred from the Village of Deloro that is presently stored on the floor of the PTB.[2] In addition, approximately 32,400 m^3 of HLW will be transported from the Mine Area for consolidation under the engineered cover in the Industrial Area.

Of the approximately 261,200 m^3 of HLW in the Industrial Area, approximately 130,000 m^3 presently resides in deposits within the waste consolidation area (Areas B to F). Some of the demolition/ruin rubble might be reused as rip/rap along the Moira River bank provided it is not contaminated. The slag will be used as backfill in the deeper excavated areas to the north and south of the proposed waste consolidation area.

The remaining approximately 131,200 m^3 of HLW located in Areas G to Z (includes radioactive tailings in Area K) and the slag/potential highly leachable soil on the PTB floor (907 m^3), and the HLW to be transported from the Mine Area (32,400 m^3), will require consolidation in Areas B to F. (If future testing confirms the soil component on the PTB floor is MLS, it and the slag will be used as backfill under the simple earth [clay] caps.) The engineered cover will be placed over approximately 164,500 m^3 of HLW. Additional waste materials identified during construction work will be similarly consolidated.

Through the excavation and consolidation of approximately 131,200 m^3 of HLW from the riverbank and north and south Industrial Areas, the footprint of HLW will be reduced from approximately 236,700 m^2 to approximately 60,000 m^2. During the final design, a three-dimensional model of the waste consolidation area will be required to refine the volume of HLW that can be consolidated in the area, the grading of the waste consolidation area, and the final dimensions of the waste consolidation area footprint. In the event that the three-dimensional model indicates that the waste consolidation area has insufficient volume to store all of the identified HLW; areas N, Q, T, and G have been identified as potential waste consolidation expansion areas. Table 2.2 identifies the estimated area of the distinct Industrial Area regions and the estimated volume of HLW in each distinct region.

TABLE 2.2
HIGHLY LEACHABLE WASTE IN THE DISTINCT REGIONS OF THE INDUSTRIAL AREA

Distinct Region of the Industrial Area	Areas in Distinct Region	Area of Region (m^2)	Highly Leachable Waste in Region (m^3)
Equalization Pond	A	7,993	–
Waste Consolidation Area	B to F	60,022	130,011
South Industrial Area	G to M	64,461	55,867
North Industrial Area	N to Y	105,025	64,531
Riverbank Reconstruction Area	Z	7,189	10,784
Total		**244,690**	**261,193**

2 The low-level radioactive slag transferred from the Village of Deloro is mixed in a matrix of soil contaminated with arsenic and will be placed under the engineered cover, unless the soil is found not to be highly leachable.

It is not the intention of the rehabilitation program to remove and consolidate all of the Industrial Area contaminated soils (HLW and MLS) under an engineered cover, as there is insufficient space in the Industrial Area. Therefore, the underlying MLS, if present, will remain in place following the excavation and consolidation of HLW under the engineered cover. Excavation and consolidation of areas of thin, discontinuous, MLS overlying bedrock will be conducted to eliminate the requirement for a simple earth (clay) cap in these areas.

The excavated portions of the Industrial Area will be backfilled to an appropriate grade that facilitates the placement of a simple earth (clay) cap to cover approximately 199,000 m^3 of MLS and slag remaining above the bedrock in the Industrial Area to the north and south of the engineered cover. The design of the simple earth (clay) cap is appropriate for MLS and is discussed in further detail below.

Excavations that extend to bedrock may remain exposed provided the grade of the bedrock is suitable to the surrounding area. All bedrock outcrops within the waste consolidation area will be covered with an engineered cover. Therefore, simple earth (clay) caps will not be required for Areas J, L, P, S, U, W, X, and Y, which occupy an area of approximately 60,100 m^2. In addition, it has been estimated that there is approximately 2,000 m^2 of smaller exposed bedrock outcrops, mostly located in Areas I, T, V, and Z. Exposed bedrock in Areas I, T, and V will not require a simple earth (clay) cap. It will be determined prior to the riverbank reconstruction program whether exposed bedrock outcrops in Area Z will be covered or remain exposed. Figure 2-1 identifies the estimated extent of the engineered cover and the simple earth (clay) caps in relation to the bedrock outcrops and riverbank reconstruction.

Consolidation, grading, and covering/capping of the Industrial Area will affect existing pumping stations, inspection holes, monitoring wells, and the overland forcemain from the Tuttle Shaft. The pumping stations, inspection holes, and monitoring wells will require modification to extend these to the new final grade. The existing forcemain from the Tuttle Shaft will be replaced with a new aboveground pipeline as detailed in the Mine Area Closure Plan.

IA-WP#5: Simple Earth (Clay) Cap Placement

A simple earth (clay) cap will be placed over the MLS that will remain following the excavation and consolidation of the HLW. The design objectives for the simple earth (clay) cap are to:

- Minimize the infiltration of precipitation through the MLS and into the underlying groundwater
- Prevent exposure of MLS to human and ecological receptors
- Eliminate surface water runoff on the MLS and MLS sediment migration to the Moira River

The design and placement of various simple earth (clay) cap scenarios are discussed below.

Simple Earth (Clay) Cap Design. The basic design of the 150-cm thick simple earth (clay) cap is:

- 15 cm of topsoil
- 50 cm of compacted clay or other low permeability material
- 85 cm of "clean" or non-leachable, non-bioavailable (e.g. slag) backfill

In Figure 2-3, SEC-1 to SEC-3 depict three variations of the basic simple earth (clay) cap design. In SEC-1, the lower soil profile consists entirely of "clean" fill, likely imported from offsite. In SEC-2, the lower soil profile consists entirely of slag from stockpiles in the Industrial Area. (As previously noted, some of the monolithic slag materials may need to be managed and covered in place if they cannot be readily excavated.) In SEC-3, the stockpiled slag is completely utilized as backfill and "clean" fill is required to complete the lower soil profile to 65 cm below grade. A geotextile filter will be placed over the slag to prevent the migration of fine soils from the upper layers into the void space of the slag.

SEC-4 (Figure 2-3) depicts the required 150 cm of cover over the MLS; however, the design is modified to support vehicular traffic into the site while still maintaining the simple earth (clay) cap design objectives. The SEC-4 design includes:

- 30 cm of Granular 'A' compacted to 98 percent SPMDD
- 55 cm of Granular 'B' compacted to 98 percent SPMDD
- 65 cm of compacted clay or other low permeability material

SEC-4 may be completed at grade with an optional layer of asphalt.

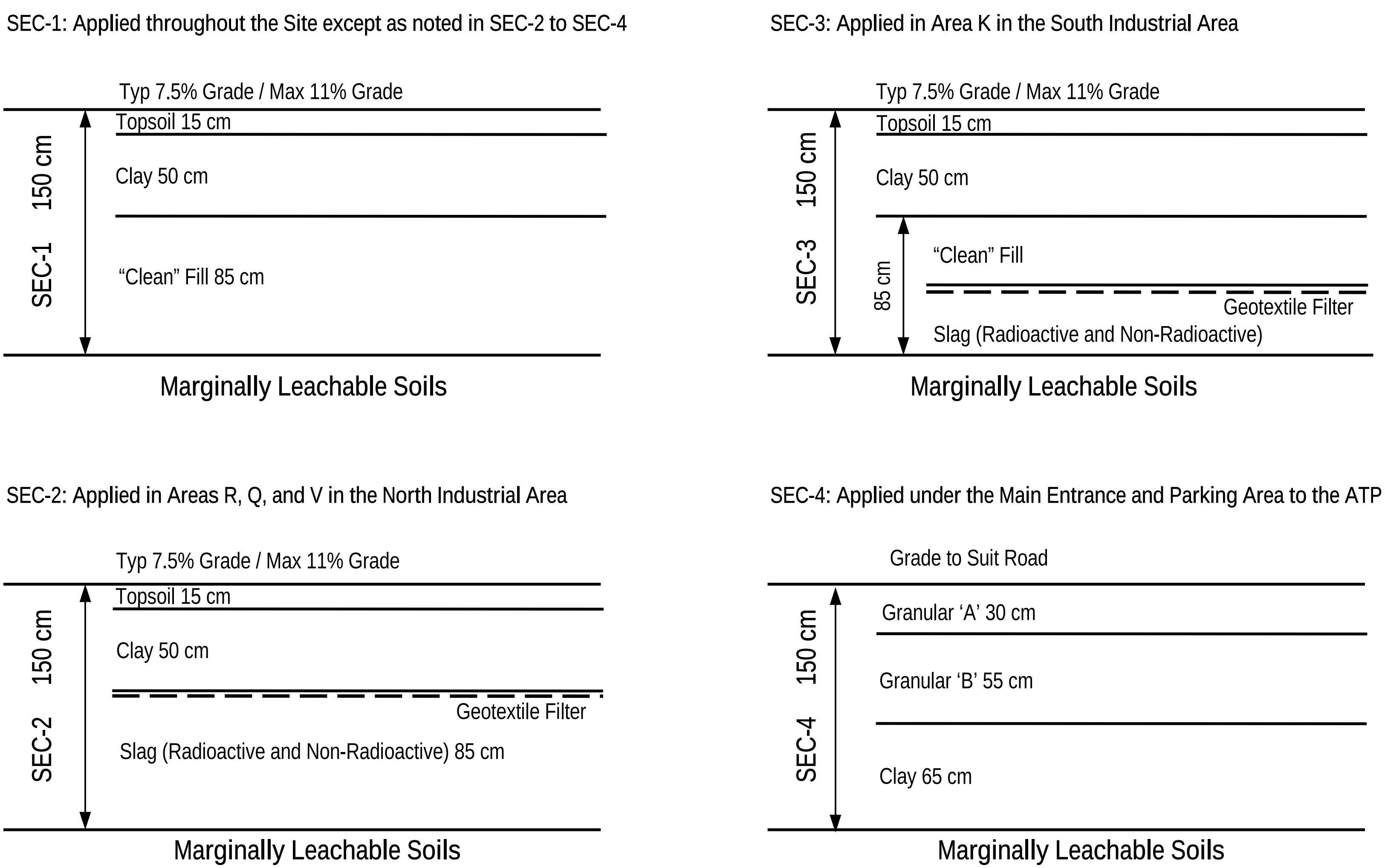
Figure 2-4 provides a profile of the interface between SEC-4, SEC-1, and the engineered cover. This interface only applies to a small portion of the entrance to the site, as the majority of SEC-4 will have exposed bedrock on the south side and the engineered cover on the north. Unlike SEC-1 to SEC-3, SEC-4 includes a partial application of a geosynthetic clay liner (GCL) and subsurface drainage techniques to intercept and divert infiltration. A typical two percent crown on the road surface and one percent crown on the underlying clay layer would assist in minimizing ponded water. The boundary between the granular soils and the engineered cover and SEC-1 will be lined with GCLs and a 100-mm collector tile, to divert percolation through the granular road layers away from the sand drainage layer of the engineered cover and the "clean" fill layer of SEC-1.

Slag Placement. Following the excavation of HLW from the North and South Industrial Area, excavations equal to or deeper than 1.5 m will be considered for the placement of slag. At present these include Areas R, Q, V, and K.

The reuse of slag as backfill (with the possible exception of the monolithic slag) reduces the cost of importing "clean" fill to the site for excavated areas and the cost of specifically placing a simple earth (clay) cap over the slag to prevent exposure to low-level radiation or dust. Excluding the slag stored on the PTB floor slab, slag has been identified in Areas E, F, G, H, I, M, and Z occupying an area of approximately 17,004 m^2 and ranging from an estimated 1.0 to 3.1 m in average thickness.

In addition, there are 32 200-L drums of cobalt ore/slag (approximately 6 m^3) and a slag pile (approximately 3 m^3) in the castings building in Area F, and there is an unknown, though likely minor, quantity of slag on the ground surface in Area Y near the former boarding houses. A small quantity of slag (approximately 5 m^3) will be transferred from the Mine Area for reuse as backfill in the Industrial Area.

Table 2.3 identifies the area and volume of slag (approximately 39,426 m^3) available for reuse in the Industrial Area and provides a strategy for the reuse of the slag as excavation backfill.



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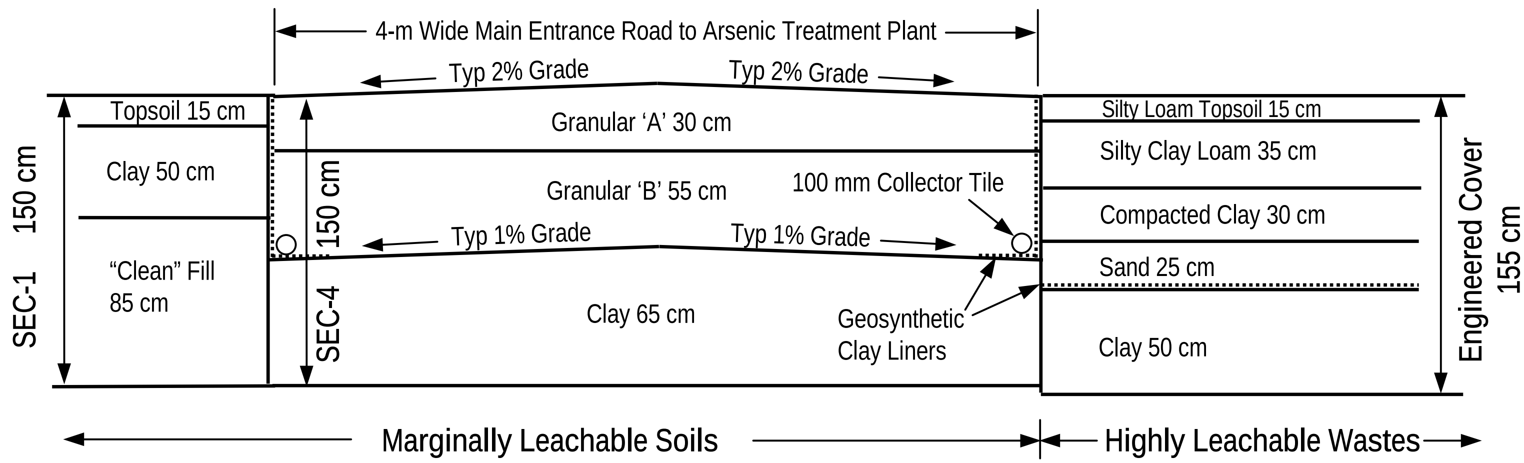
Industrial Area

Figure 2-3
Profiles of Simple Earth (Clay) Caps (SEC-1 to SEC-4) over Marginally Leachable Soils



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Integrated Cleanup Plan
Industrial Area

Figure 2-4
Profile of SEC-4 Interface with SEC-1 and Engineered Cover at Main Entrance Road

Table 2.3
Slag Inventory and Strategy for Reuse as Backfill

Area I.D.	Surface Area of Slag (m^2)	Mean Depth of Slag (m)	Approx. Volume of Slag (m^3)	Strategy for Reuse of Slag as Excavation Backfill *
MA	-	-	5	Temporary transfer to Area G to accommodate the Mine Area rehabilitation
F - CB pile	-	-	3	Temporary transfer the pile of cobalt ore/slag from CB to Area G prior to CB demolition
F - CB drums	-	-	6	Temporary transfer the 32 - 200 L drums of gravelly slag from CB to Area G prior to CB demolition
Z	1,250	1.0	1,250	Temporary transfer to Area G to accommodate the riverbank reconstruction program
Y	-	-	?	Temporarily transfer unknown quantity of non-radioactive slag from boarding house ruins to Area G
H	1,500	1.0	1,500	Transfer to Area R
M	2,100	2.0	4,200	Transfer 3,937 m^3 to Area R and 263 m^3 to Area Q
E	3,750	3.1	11,750	Transfer to Area Q
I	2,250	1.0	2,250	Transfer 880 m^3 to Area Q and 1,370 m^3 to Area V
G	6,154	3.0	18,462	Transfer 8,743 m^3 to Area V, 9,719 m^3 to Area K, then the 1,264 m^3 of temporarily stored MA, Area F and Area Z slag to Area K
Grand Totals	17,004		39,426	

Notes:
* Strategy for slag reuse is based on the estimated available volumes in the excavations listed in the Industrial Area (IA) Closure Plan. Scheduling changes will affect the reuse strategy
CB = Castings Building
MA = Mining Area slag to be used as backfill in IA
? = Unknown quantity, though likely minor, of non-radioactive slag in Area Y

At present, it is estimated that there will be approximately 51,570 m^3 of excavation space below an excavation depth of 0.65 metres below ground surface (mbgs) available for slag backfill, including:

- Approximately 5,437 m^3 available for slag backfill in the Area R excavation
- Approximately 12,892 m^3 available for slag backfill in the Area Q excavation
- Approximately 10,113 m^3 available for slag backfill in the Area V excavation
- Approximately 23,128 m^3 available for slag backfill in the Area K excavation

Following the reuse of the estimated 39,426 m^3 of slag, it is anticipated that Area K could accommodate an additional 12,144 m^3 of slag, should more be identified during the consolidation activities.

SEC-2 will be applied to Areas R, Q, and V and SEC-3 will be applied to Area K. As mentioned, the slag backfill will be covered with a geotextile filter to prevent the migration of fines into the slag. The simple earth (clay) cap designs (SEC-1 through SEC-4) also minimize the risk of mammals burrowing into the underlying wastes and have a thickness of 1.5 m, as required by the draft SLERA.

The approximate pre-cleanup locations of low-level radioactive materials and associated low-level radiation fields (at 1 m above ground surface) in the Industrial Area, as well as in the Mine Area, Tailings Area, and Young's Creek Area are shown in Figure 2-5. (With exception, the low-level radioactive fields, associated with the above-noted low-level radioactive slag transferred from the Village of Deloro that is presently stored on the floor of the PTB, are not identified in Figure 2-5 since this material was transferred to the site in 1999 after the site radiation survey was undertaken in 1997 by CH2M HILL). All low-level radioactive materials will be excavated and/or covered in the Industrial Area and other areas of the site (see below) such that the radiation fields will be reduced to background levels of 0.03 to 0.06 μSv/h.

IA-WP#6: Engineered Cover Placement

An engineered cover will be placed over the consolidated wastes to:

- Minimize the infiltration of precipitation through the HLW and into the underlying groundwater
- Prevent exposure of HLW to human and ecological receptors
- Eliminate surface water runoff on the HLW and HLW sediment migration to the Moira River

The design and placement of the engineered cover are discussed below.

Hybrid Poplar Tree Cover Design. The design criteria for the engineered cover required the development of a specific soil profile that is capable of supporting plant life as well as providing hydraulic control of infiltration. The design basis of a hybrid poplar tree cover system is to manage water and reduce and/or eliminate deep percolation of precipitation through the engineered cover. The cover design proposed for the Industrial Area incorporates moisture retention layers to hold excess percolation until it can be taken up by means of evapotranspiration during the summer growing season by the trees. It also includes barrier layers to prevent vertical flow and a drainage layer.

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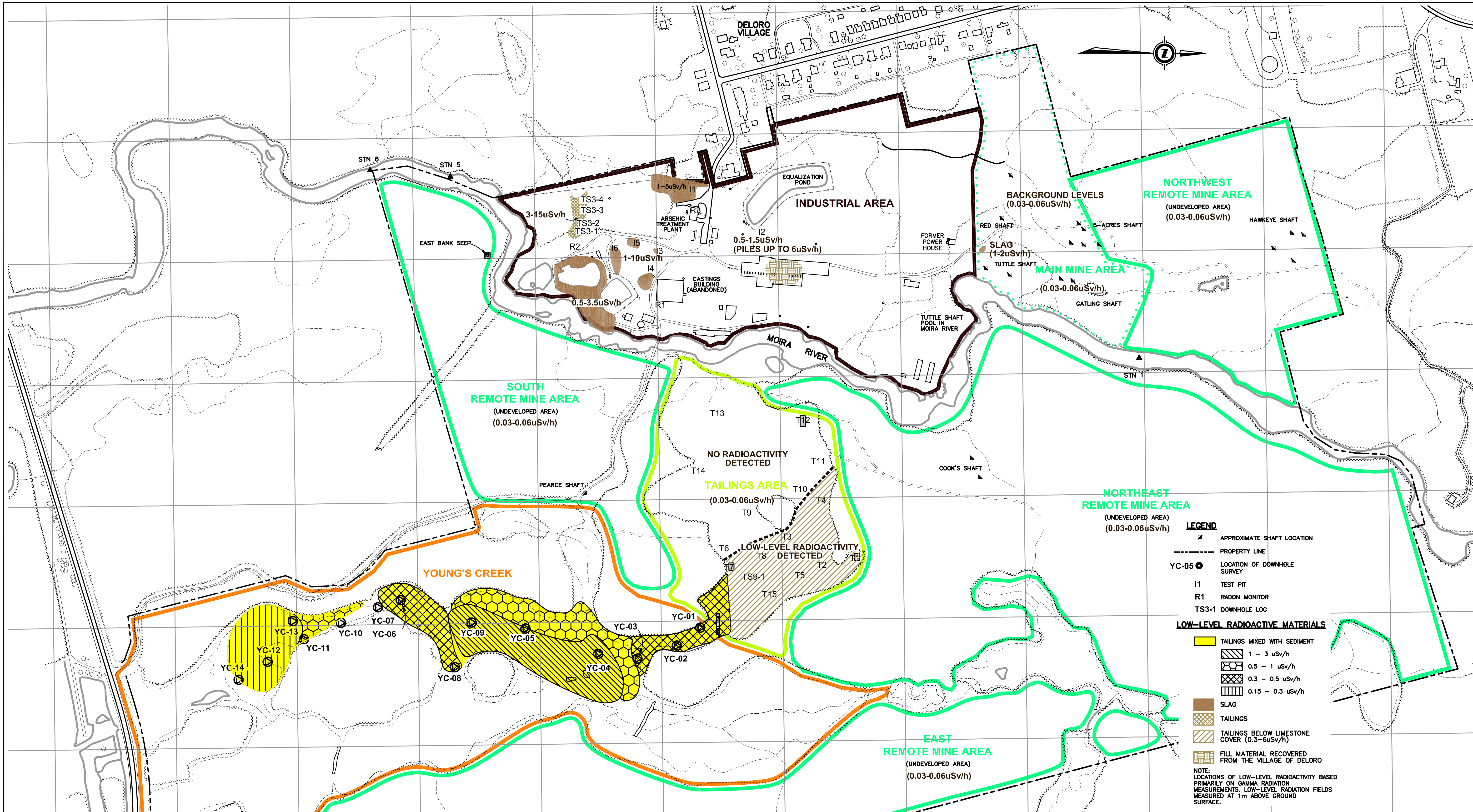

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INTEGRATED CLEANUP PLAN

FIGURE 2-5
APPROXIMATE LOCATIONS OF
LOW-LEVEL RADIATION FIELDS

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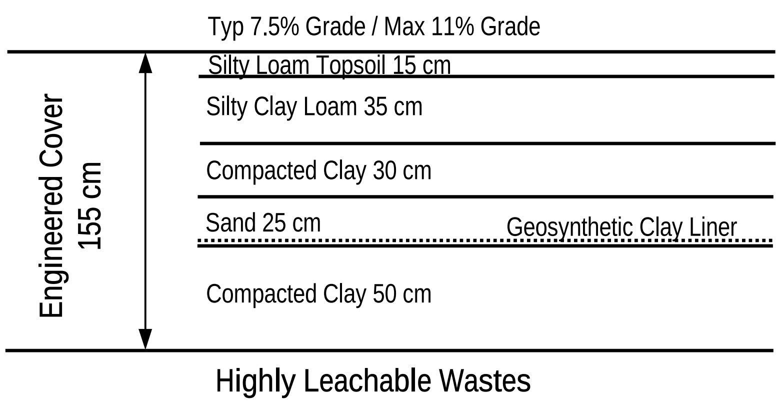
The cover will have a high runoff coefficient to minimize infiltration and saturation of the upper layers during spring runoff and times of heavy precipitation. Early tree growth in May creates unsaturated zones within the cover and forms a barrier to new infiltration. Rapid growth during the warm, dry summer months then extends the unsaturated zones to the entire cover. Infiltration from autumn precipitation is absorbed and held by soil suction throughout the winter months when no infiltration occurs.

The treed cover concept takes advantage of the tremendous potential water uptake capability of hydrophilic tree species such as the locally common poplar and red maple. Data from modelling undertaken by CH2M HILL for the Deloro Mine Site indicates that, when planted at an average density of one tree per 3 m^2, poplars have the potential to evapotranspire up to 633.8 mm of water in a growing season running from April to November (CH2M HILL, May 2002). Average annual precipitation in the Deloro area is approximately 900 mm; therefore, theoretically, a treed cover has the potential to evapotranspire most of the annual infiltration. In reality, trees do not reach their potential evapotranspiration because of soil moisture deficit conditions during the dry summer months, and some infiltration occurs because precipitation is not evenly distributed throughout the growing season.

CH2M HILL has refined the engineered cover design model to incorporate the treed cover concept. CH2M HILL utilized the U.S. Environmental Protection Agency's (USEPA's) Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.07, for its evaluation of poplar tree cover systems in northern climates. The modelled design of the poplar tree cover system included the soil profile layers in Table 2.4, except the GCL, which has been added to augment the modelled cover design. A profile of the engineered cover over HLW is depicted in Figure 2-6.

TABLE 2.4
ENGINEERED COVER DESIGN

Soil Layer	Depth (cm)	Rationale
Upper Soil Profile	Primarily intended to support the poplar trees and provide water storage capacity	
Silty Loam Topsoil	15	Provides the initial rooting medium and the necessary nutrients, organic material, and trace metals for initial plant growth
Silty clay loam	35	Provides soil moisture storage capacity during the non-growing season and facilitates deeper rooting
Lower Soil Profile	Further minimize percolation, permit drainage and provide additional storage capacity to increase the effectiveness of the cover during non-growing season	
Compacted Clay	30	Acts as a restrictive barrier layer to minimize percolation of water into the underlying drainage layer
Sand	25	Acts as a water collection, storage, and transport system for water that penetrates the upper layers especially during the non-growing season. Collected water is diverted away from the remainder of the engineered cover and the Industrial Area
Geosynthetic Clay Liner	NA	Forms a secondary infiltration barrier of the engineered cover
Compacted Clay	50	Acts as a secondary restrictive barrier layer to minimize percolation of water into the underlying waste



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Integrated Cleanup Plan
Industrial Area

Figure 2-6
Profile of Engineered Cover over Highly Leachable Wastes

The HELP model simulation results predict that:

- Approximately one-third of the annual precipitation leaves the area as surface runoff
- Almost two thirds of the annual precipitation leaves the area via evapotranspiration through the trees
- Only about 4 percent of the annual precipitation percolates into the lower soil profile
- An average annual reduction in percolation of 97.33 percent occurs
- The percolation into the waste is extremely low but not zero

The topsoil components must have an effective volumetric moisture storage capacity (difference of at least 15 percent between field capacity and wilting point) and an in-place hydraulic conductivity of greater than 1×10^{-5} cm/s.

The clay component of the cover should have an in-place hydraulic conductivity lower than 1×10^{-6} cm/s (ideally 1×10^{-7} cm/s) and be compacted to a minimum of 95 percent SPMDD at a near-optimum moisture content. The sand drainage layer was added to the engineered cover design to provide seasonal water storage and lateral drainage. Volume displacement and head created by over capacity could create adverse conditions for growth of the plantation and compromise the integrity of the clay layer if lateral drainage does not occur. Appropriate grading of the underlying compacted clay layer would initiate the lateral flow of any deep percolation away from the remainder of the engineered cover and the Industrial Area. This flow would not be in contact with the waste material and, therefore, could be allowed to discharge outside of the Industrial Area without further treatment.

The GCL will be placed over the lower clay layer to form a secondary infiltration barrier of the engineered cover. The GCL's non-woven outer geotextile cover provides high strength in tension and against puncture. The inner layer of sodium bentonite swells under contact with moisture to provide a hydraulic barrier. The barrier is effective in resisting stresses from differential settlement.

The engineered cover design minimizes the risk of mammals burrowing into the underlying wastes, and is at least 1.5 m thick, as required by the draft SLERA. Burrows may follow the buried topsoil layer rather than penetrating deeper into the compacted clay and wastes. The treed cover has the potential to evapotranspire water that infiltrates through burrows. It also provides protective cover for common predators such as foxes and coyotes. The presence of these predators will further discourage burrowing in the cover structure.

The cover design may vary slightly, depending on the local availability of cover materials at the commencement of construction activities and the cost of transporting imported cover materials from distant sources. The HELP model will be revisited to address future redesigns of the engineered cover.

Construction of Engineered Cover. The engineered cover will be placed over an area of approximately 60,000 m^2. Initially a clay berm approximately 5-m wide at the base and extending approximately 2 m to an elevation of 197 m, will be constructed around the perimeter of the equalization pond. The mound of HLW will be extended in a radial manner from the equalization pond at a 7.5 to 11 percent grade. As the mounded HLW approaches a grade of 11 percent (maximum), the mound will be progressively covered with a 50-cm layer of clay and compacted to 95 percent SPMDD. This clay is the lowest layer of the

engineered cover. At the end of the construction program, when the HLW has been completely consolidated under the lower clay layer, the final layers of the engineered cover will be placed. This approach allows for reworking the dimensions of the mound to accommodate increased HLW volumes and modifications to the mound side slopes with minimal damage to the cover. The top of the 1.55-m thick engineered cover will connect to the clay berm at an elevation of 196.5 m, allowing for a 45-cm swale to divert mound runoff from the equalization pond.

Consolidation of HLW will commence with the riverbank reconstruction wastes, which will be consolidated in Area B, east of the equalization pond adjacent to the clay berm. The low-level radioactive slag mixed with potentially highly leachable soil on the PTB floor will be consolidated in the WCA unless additional analyses indicate that the soil is not highly leachable. The Mine Area wastes should be consolidated in Area B prior to the excavation of wastes and the Mine Area access road, in Areas R and T.

HLW from the North Industrial Area will be consolidated in Areas D, C, B, and the north half of Areas E and F. HLW from the South Industrial Area will be consolidated in the south half of Areas F and E. Areas N, Q, T and G have been designated as a potential extension to the WCA, should quantities of the current WCA (Areas B to F) not have sufficient capacity to accommodate increased volumes of HLW.

The exposed face of the HLW mound will be temporarily tarped using a high-density polyethylene (HDPE) liner of sufficient thickness weighted with sand bags. The mound will be tarped at the end of every workday to prevent exposure, wind transport, and sediment runoff during storm events. At the end of each construction season, the mound will either be completely encapsulated in the 50-cm lower clay layer or partially encapsulated with the remaining exposed face covered with the HDPE liner.

IA-WP#7: Installation of Groundwater Interceptor Well Network

The GIWN is anticipated to comprise of a horizontal well advanced into the bedrock on the west side of the Industrial Area and a series of vertical pressure relief wells extending into the deeper bedrock. The vertical pressure relief wells would flow by artesian pressure and would be connected to, or be in close proximity of, the horizontal well. The GIWN will lower the water table under the wastes to below the bedrock surface and divert clean groundwater from the wastes.

The GIWN will be a completely passive operation, which is supportive of the site-wide closure objective of minimizing perpetual operation and maintenance.

A more detailed description of the proposed GIWN is provided below:

- A stainless steel screened horizontal well, approximately 500 m in length and 203 mm in diameter, placed several metres into the bedrock at a “level” elevation of 185.3 m along the west side of the waste consolidation area
- Approximately 373 m of 203-mm diameter, HDPE piping (also advanced using horizontal drilling) to convey the water from the outlet of the horizontal well screen southward to the river
- Eight 150-mm diameter, polyvinyl chloride (PVC) pressure relief wells, extending approximately 30 m into bedrock and connected to the horizontal well to reduce the hydraulic head of the groundwater in the deep bedrock

- Four 3.7 m by 3.7 m vertical shafts, installed at four of the pressure relief wells, and extended into the overburden and bedrock to the underside of the horizontal well. These shafts would be designed to provide access to the horizontal and vertical wells at these locations to facilitate direct piping connections and for access for future flow control and monitoring, if desired. At the remaining four locations of the pressure relief wells, the system would rely on hydraulic connections between the wells through fractures in the bedrock. The hydraulic connections would be enhanced by hydraulic fracturing of the four vertical bedrock wells, to increase the hydraulic conductivity of the bedrock aquifer, thereby enhancing the flow of groundwater into the horizontal well under existing vertical hydraulic gradients
- A groundwater flow control mechanism in the form of a valve or weir at the outlet of the conveyance pipe, as well as an accumulating flow meter

A preliminary conceptual layout of the GIWN is shown in Figure 2-7 and the approximate depth of the horizontal well is shown in Figure 2-8. Verification of the layout, depths, and spacing of the horizontal and vertical pressure relief wells and the vertical shafts will need to be further assessed during additional hydrogeological field investigations at the site and additional groundwater flow modelling.

The timing of the commencement of operation of the groundwater system is very important to manage and minimize the possibility of contaminated water entering the interceptor system from under the encapsulated area.

The groundwater interceptor system, in conjunction with the existing pumping system and the planned engineered cover, is necessary to dewater the overburden under the encapsulated area, to minimize contamination entering the bedrock/Moira River from under the wastes.

The order of construction involves first constructing the engineered cover over the highly leachable wastes to reduce infiltration of rainfall and to divert surface water runoff from this area. This will allow the waste to drain and, with the continuing operation of the pumping stations, the contaminated water draining from the waste will be pumped to the treatment system. The reduction in flows should be observed as well as groundwater levels to evaluate when the system with the engineered cover has reached steady-state.

Secondly, during the above observational phase, the groundwater interceptor system can be installed but maintained in standby mode. Once the engineered cover/wastes/pumping stations monitoring has indicated no further decline in groundwater levels or groundwater flow volumes from the pumping stations will occur then the interceptor system can be commissioned. The discharge from the interceptor system can be controlled so that the decline in groundwater levels under the encapsulated waste can be gradually lowered, then optimized. Monitoring of the groundwater levels, pumping station flows, and groundwater chemistry from both discharges of the interceptor system and the pumping stations will be undertaken at regular intervals. No “pulse” of contaminated groundwater is expected to move to the Moira River as the pumping station operation will be maintained for as long as needed.

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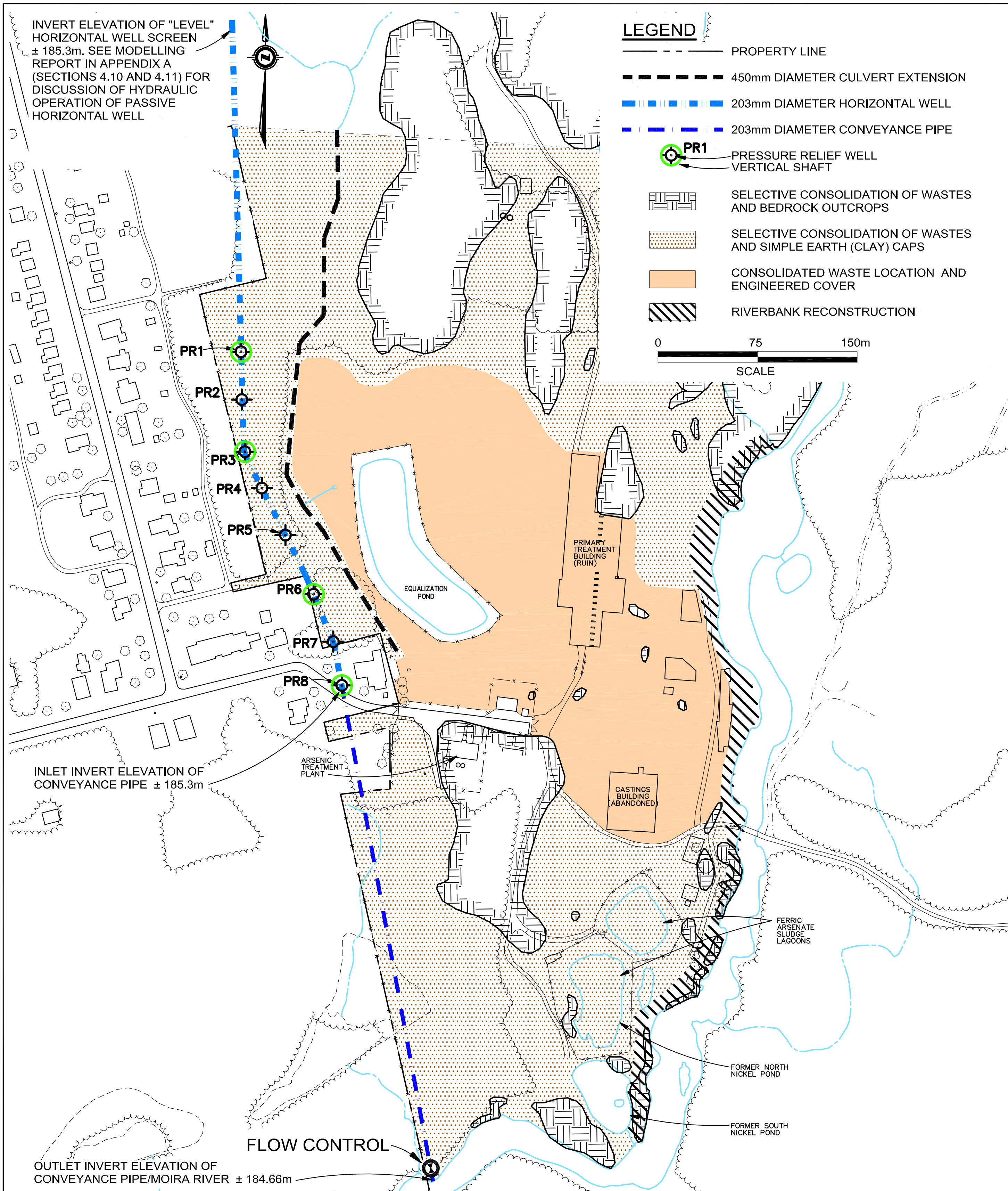

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-7
CONCEPTUAL LAYOUT OF HORIZONTAL GROUNDWATER INTERCEPTOR WELL NETWORK

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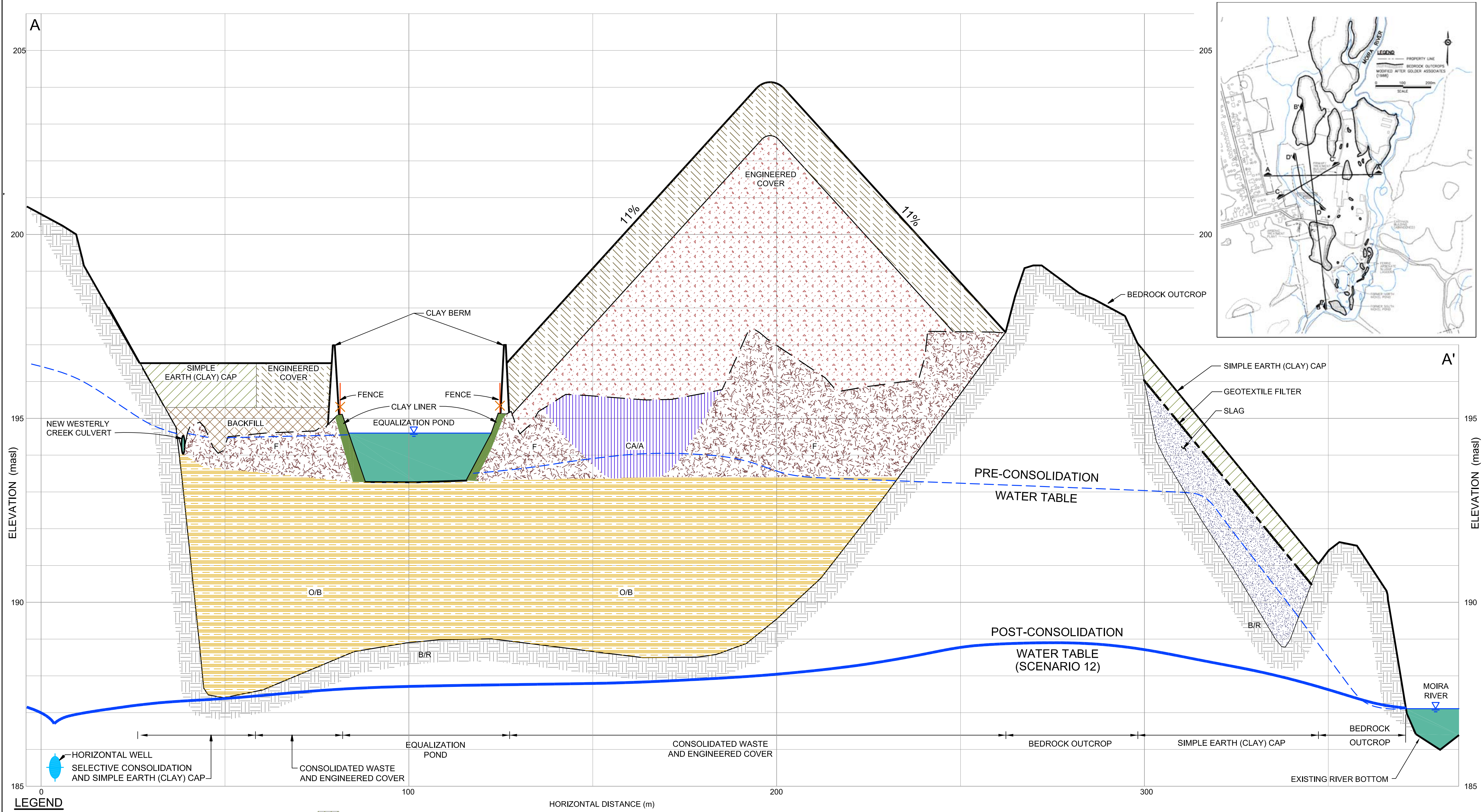

LEGEND

- B/R - BEDROCK
- F - FILL
- O/B - OVERBURDEN
- SLAG
- CONSOLIDATED WASTES
- BACKFILL
- CA/A - CALCIUM ARSENATE/ARSENITE
- CLAY LINER
- SIMPLE EARTH (CLAY) CAP
- ENGINEERED COVER

SECTION A-A'

H. SCALE 1:1000
VERTICAL EXAGGERATION ~10X

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-8
WEST-EAST CROSS-SECTION THROUGH POST-CONSOLIDATION INDUSTRIAL AREA

PROJECT No. 119548

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The groundwater interceptor can be constructed at the optimum time that will depend on site operations regarding access and other activities that are ongoing. (As shown in Figure 2-12B, the groundwater interceptor system will be installed in the third year of the estimated condensed three-year cleanup schedule). It will become operational after encapsulation and initial drainage of the wastes, as verified by the above-noted monitoring.

The GIWN will be designed and operated to minimize the potential for drawing contaminated groundwater from below the waste consolidation area into the horizontal and vertical wells, thereby minimizing requirements for treatment of the intercepted groundwater, if at all, to allow discharge of the water to the Moira River. Conservative contaminant transport modelling may be undertaken to confirm the present analysis that the potential for contaminated groundwater to enter the horizontal and vertical wells, from under the engineered cover, is low. Currently, it is predicted that groundwater coming from the shallow bedrock under the engineered cover to the horizontal well and vertical wells will be diluted by a factor of approximately 12.9:1, when the entire flow into the system is considered.

If the interceptor water quality does not meet the discharge criteria, contingency plans may include:

- A temporary increase in pumping at the existing or new pumping stations, to reduce/ minimize contaminants drawn into the groundwater collection system.
- Modification of the operating level in the interceptor to avoid collecting impacted groundwater
- Treatment of the collected groundwater using a natural treatment system (e.g. wetland), prior to discharge to the Moira River
- Treatment of the collected groundwater at the ATP, if feasible

Based on modelling results contained in the Industrial Area Closure Plan, the proposed GIWN would lower groundwater levels beneath the waste consolidation area to below the bedrock surface, approximately three to four metres below the base of the calcium arsenate/ arsenite wastes. This would reduce the potential for continued contaminant dissolution in groundwater through direct contact with the wastes and the migration of contaminated groundwater eastward towards the Moira River. The existing groundwater levels and predicted groundwater levels, following implementation of the GIWN, are shown in Figures 2-8 and 2-9. This scenario assumes that some of the existing groundwater pumping stations would continue to operate to capture contaminated groundwater from beneath the waste consolidation area, at least until such time as groundwater pumping and treatment are no longer required.

Figures 2-8, 2-9, and 2-10 also illustrate the overburden and bedrock conditions beneath the Industrial Area, the preconsolidation waste profiles, and profiles following consolidation and capping activities.

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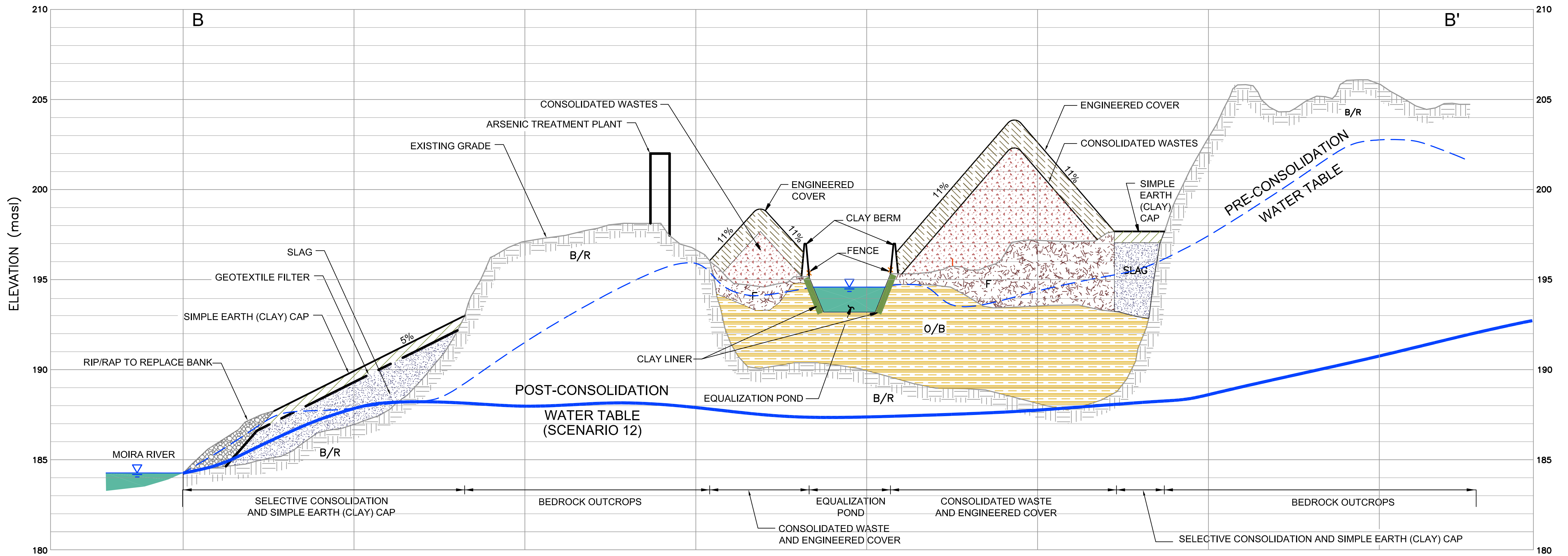
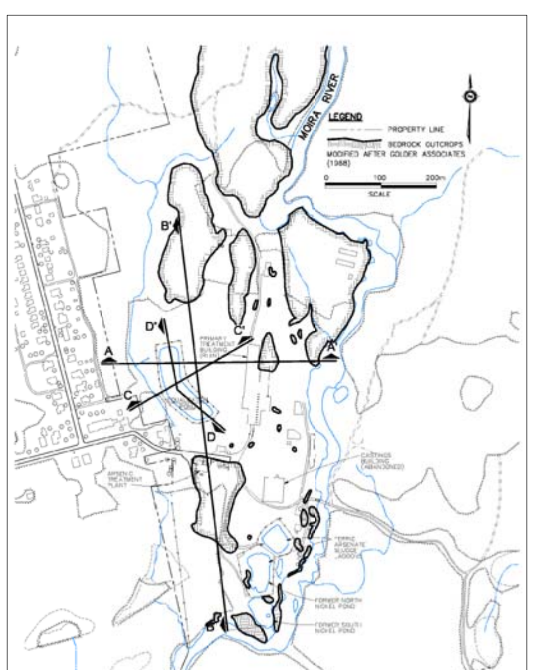


SECTION B-B'
H. SCALE 1:2500
VERTICAL EXAGGERATION ~10X



LEGEND

B/R - BEDROCK	CONSOLIDATED WASTES
F - FILL	BACKFILL
O/B - OVERBURDEN	SLAG
CLAY LINER	SIMPLE EARTH (CLAY) CAP
	ENGINEERED COVER
	RIP/RAP

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-9
SOUTH-NORTH CROSS-SECTION THROUGH POST-CONSOLIDATION INDUSTRIAL AREA

PROJECT No. 119548

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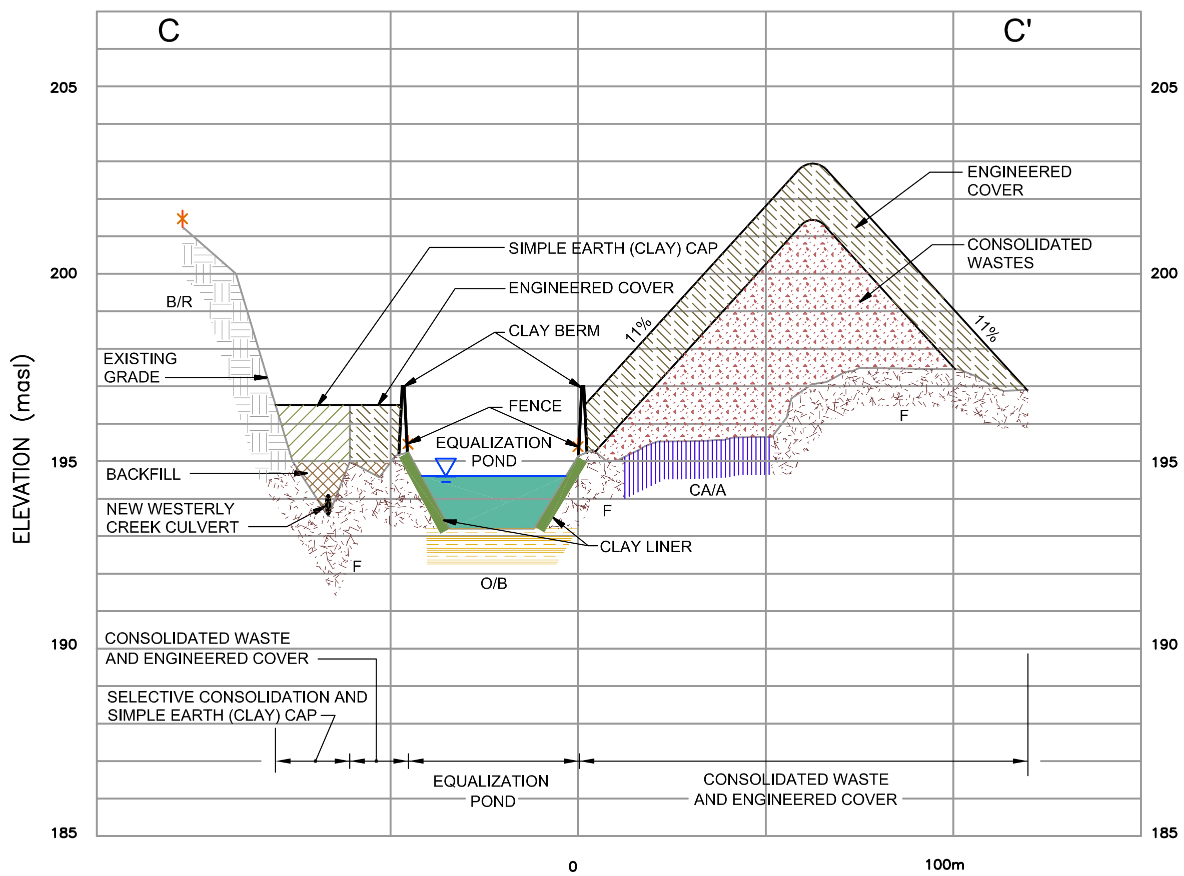
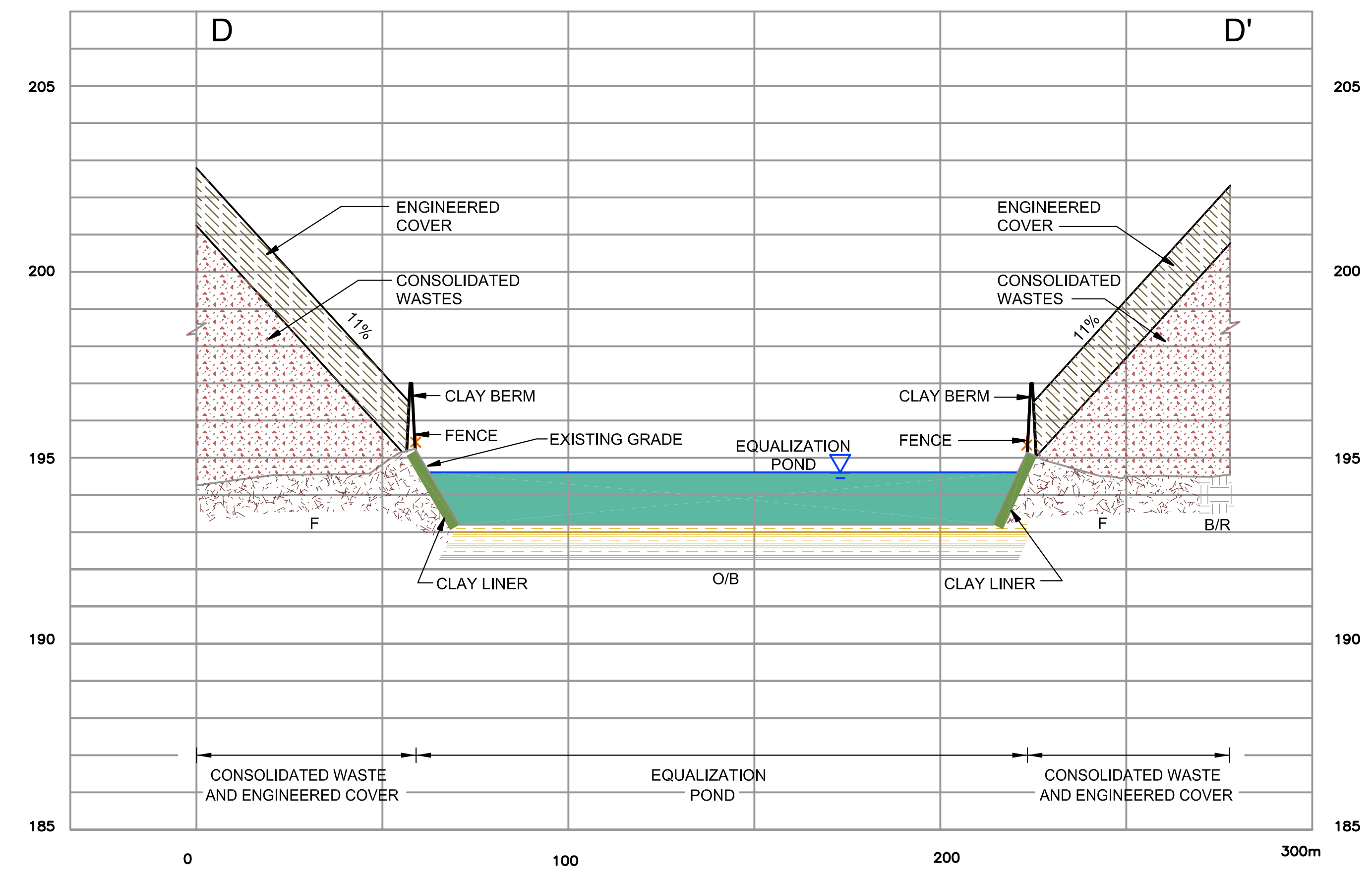


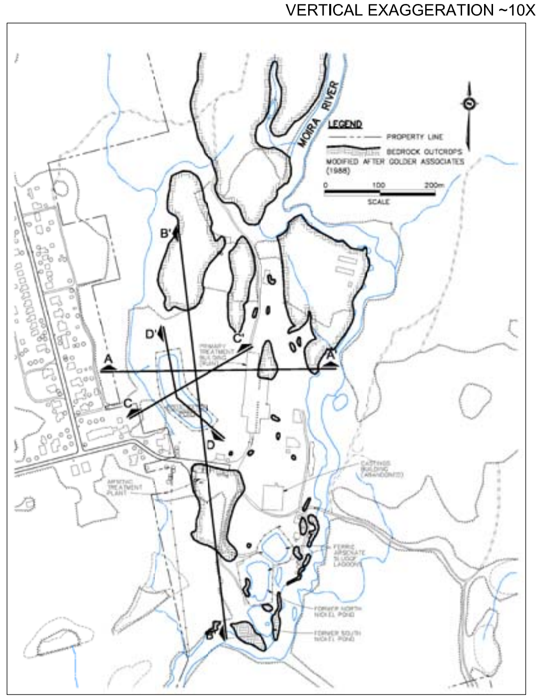
SECTION C-C'

H. SCALE 1:2000
VERTICAL EXAGGERATION ~10X



SECTION D-D'

H. SCALE 1:2000
VERTICAL EXAGGERATION ~10X



LEGEND

- B/R - BEDROCK
- F - FILL
- O/B - OVERBURDEN
- CONSOLIDATED WASTES
- BACKFILL
- CA/A - CALCIUM ARSENATE/ARSENITE
- SIMPLE EARTH (CLAY) CAP
- ENGINEERED COVER
- CLAY LINER

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INTEGRATED CLEANUP PLAN
INDUSTRIAL AREA

FIGURE 2-10
EQUALIZATION POND CROSS-SECTIONS THROUGH POST-CONSOLIDATION INDUSTRIAL AREA

PROJECT No. 119548

IA-WP#8: Site Revegetation

The completed engineered cover will be vegetated with both poplar trees and grass. The grass cover is intended for short-term erosion control until the tree cover is well established. Grass will eventually be shaded out as the canopy of the plantation reaches crown closure. With maturity, the trees' thick root system holds the soil together and the canopy of leaves shields the ground from raindrop impacts and consequent erosion. When the leaves fall in the autumn, they contribute to the mulch at the site and the overall water-holding capacity of the system. With time, the cover becomes a mature forest with little wind or water erosion.

The completed simple earth (clay) caps (SEC-1 to SEC-3) will be grassed only, as the topsoil layer provides for a shallow rooting structure that will not adequately support trees.

Westerly Creek

Westerly Creek has been re-aligned numerous times throughout the history of the Deloro site prior to being located at its present location, New Westerly Creek. The Industrial Area will be re-graded following implementation of the recommended cleanup plan. Surface water drainage will continue to drain to the Moira River through a series of ditches and swales. The approximate surface water runoff flowpaths under post-closure conditions are illustrated in Figure 2-1B, as previously noted. This will include draining the portion of the existing Westerly Creek channel that will be beneath the simple earth (clay) cap into a 450-mm diameter concrete culvert (see Figure 2-7). The new culvert will drain into an existing culvert, located near the main site entrance, that currently conveys flow from the existing Westerly Creek (north portion) to the downstream portion of Westerly Creek.

The MOE will be carrying out soil and surface water sampling in the downstream marshy area around New Westerly Creek, to determine the levels of arsenic and heavy metals such as cobalt, copper and nickel. It is expected that the soil concentrations will be similar to those found in the village of Deloro as part of the Deloro Village Environmental Health Risk Study. An action plan to address soil or surface water contamination issues will be developed, if required. The removal/disposal of contaminated material will be included as part of the site cleanup, if necessary.

Leachate Treatment

The MOE has implemented various remediation strategies to reduce the arsenic loading to the Moira River since assuming control of the site in 1979. The Ontario Clean Water Agency (OCWA) operates the ATP and groundwater collection system on behalf of the MOE. Annual average withdrawal rates of approximately 100,000 m^3/year have had a significant positive impact on Moira River water quality. The arsenic loading to the Moira River has been reduced by more than 80 percent to an annual average of less than 10 kg/day, since the ATP was placed into operation in 1983. Table 2.5 summarizes the ATP performance.

TABLE 2.5
DELORO ARSENIC TREATMENT PLANT PERFORMANCE

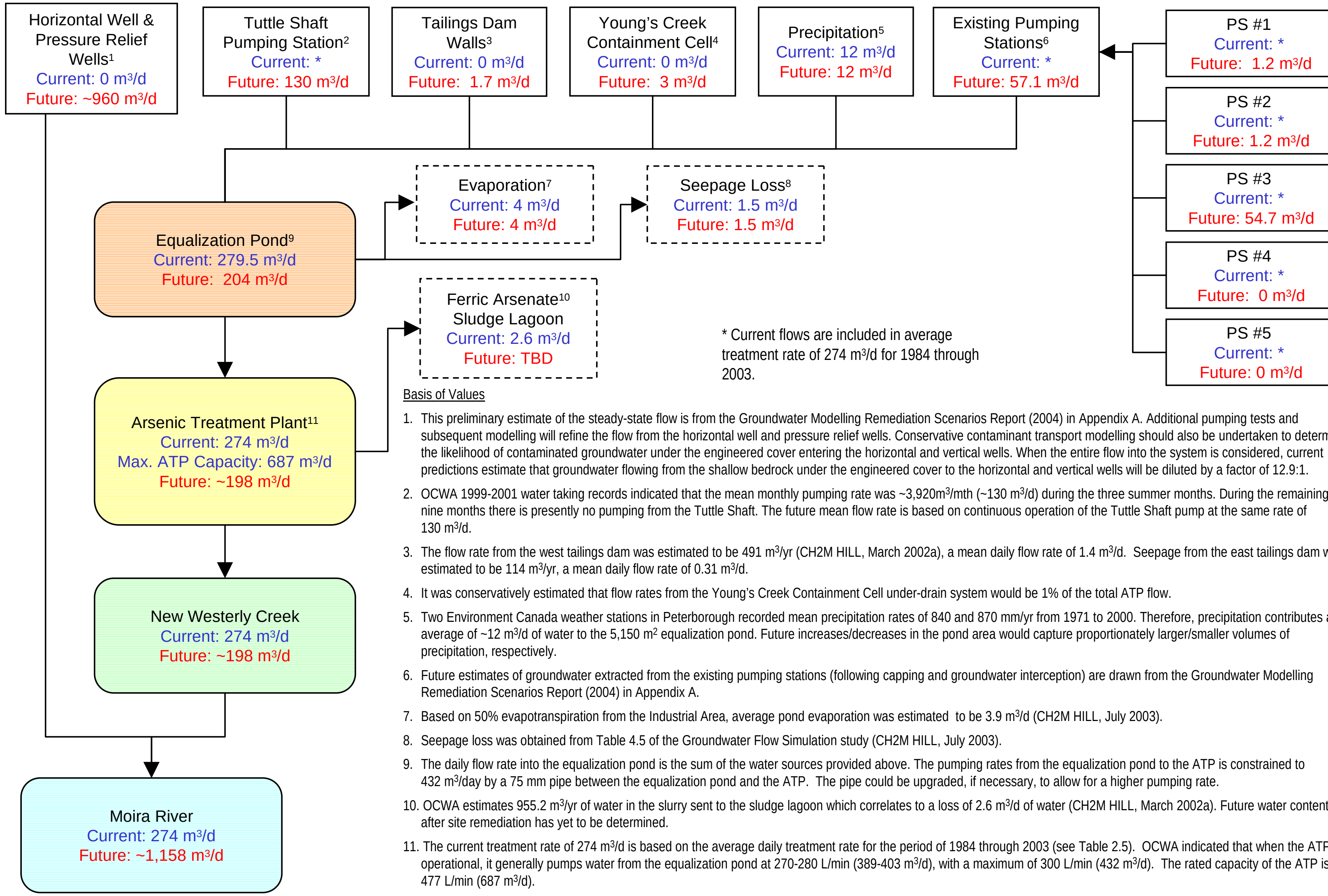
Year	Water Treated (m^3/yr)	Influent As (mg/L)	Effluent As (mg/L)	Treatment Efficiency (%)	Arsenic Removed (kg)
1984	82,295	189	0.361	99.8	17,787
1985	127,705	133	0.202	99.8	14,294
1986	168,422	89	0.223	99.7	13,561
1987	153,610	87.775	0.153	99.8	13,273
1988	164,341	99.334	0.127	99.9	15,729
1989	104,567	120.741	0.177	99.9	11,733
1990	99,842	110.071	0.194	99.8	10,913
1991	*	144.499	0.227	99.8	*
1992	87,139	161.714	0.199	99.9	12,734
1993	88,717	138.141	0.223	99.8	11,478
1994	169,868	105.313	0.187	99.8	16,380
1995	78,528	112.173	0.151	99.9	8,618
1996	86,525	147.696	0.164	99.9	12,738
1997	59,414	146.12	0.22	99.8	8,608
1998	65,099	127.50	0.27	99.8	8,346
1999	72,284	93.01	0.11	99.9	6,395
2000	71,439	125.43	0.19	99.9	8,905
2001	68,383	101.74	0.14	99.9	9,900
2002	72,010	116.23	0.17	99.8	8,542
2003	77,692	108.71	0.14	99.9	8,722
Average (excluding 1991)	99,888 m^3/yr (274 m^3/day)				

* Problem with Flow Meter
Source: OCWA, 1997a

Similarly, the average annual arsenic concentrations in the Moira River decreased from 0.33 mg/L in 1979 to 0.03 mg/L in 1994, as measured at the Highway 7/Moira River monitoring station.

Figure 2-11 identifies the current volumes of water that are pumped to the ATP, and the anticipated future steady-state flow rate to the ATP following the implementation of the remedial measures.

As shown in Figure 2-11, the ATP will receive increased new flows from the proposed Tailings Area leachate collection system and the Tuttle Shaft, due to the planned increase to year-round pumping from several months of pumping per year, and from the proposed onsite containment cell in the Young's Creek Area. However, as shown in Figure 2-11, the overall future flow to the ATP is expected to decrease (from an average of 274 m^3/d to approximately 198 m^3/d) as a result of the anticipated reduction in flow rates from the existing pumping stations. The anticipated reduction in the average future flow to the ATP can be mostly attributed to the proposed GIWN, reducing the flows from the existing pumping stations, and more than offsetting the new flows. It is also anticipated that contaminant concentrations will decrease with time as contaminated groundwater is removed from beneath the waste area and assuming that new leachate is not generated through direct contact of uncontaminated groundwater with the wastes.



Basis of Values

1. This preliminary estimate of the steady-state flow is from the Groundwater Modelling Remediation Scenarios Report (2004) in Appendix A. Additional pumping tests and subsequent modelling will refine the flow from the horizontal well and pressure relief wells. Conservative contaminant transport modelling should also be undertaken to determine the likelihood of contaminated groundwater under the engineered cover entering the horizontal and vertical wells. When the entire flow into the system is considered, current predictions estimate that groundwater flowing from the shallow bedrock under the engineered cover to the horizontal and vertical wells will be diluted by a factor of 12.9:1.
2. OCWA 1999-2001 water taking records indicated that the mean monthly pumping rate was ~3,920m^3/mth (~130 m^3/d) during the three summer months. During the remaining nine months there is presently no pumping from the Tuttle Shaft. The future mean flow rate is based on continuous operation of the Tuttle Shaft pump at the same rate of 130 m^3/d.
3. The flow rate from the west tailings dam was estimated to be 491 m^3/yr (CH2M HILL, March 2002a), a mean daily flow rate of 1.4 m^3/d. Seepage from the east tailings dam was estimated to be 114 m^3/yr, a mean daily flow rate of 0.31 m^3/d.
4. It was conservatively estimated that flow rates from the Young's Creek Containment Cell under-drain system would be 1% of the total ATP flow.
5. Two Environment Canada weather stations in Peterborough recorded mean precipitation rates of 840 and 870 mm/yr from 1971 to 2000. Therefore, precipitation contributes an average of ~12 m^3/d of water to the 5,150 m^2 equalization pond. Future increases/decreases in the pond area would capture proportionately larger/smaller volumes of precipitation, respectively.
6. Future estimates of groundwater extracted from the existing pumping stations (following capping and groundwater interception) are drawn from the Groundwater Modelling Remediation Scenarios Report (2004) in Appendix A.
7. Based on 50% evapotranspiration from the Industrial Area, average pond evaporation was estimated to be 3.9 m^3/d (CH2M HILL, July 2003).
8. Seepage loss was obtained from Table 4.5 of the Groundwater Flow Simulation study (CH2M HILL, July 2003).
9. The daily flow rate into the equalization pond is the sum of the water sources provided above. The pumping rates from the equalization pond to the ATP is constrained to 432 m^3/day by a 75 mm pipe between the equalization pond and the ATP. The pipe could be upgraded, if necessary, to allow for a higher pumping rate.
10. OCWA estimates 955.2 m^3/yr of water in the slurry sent to the sludge lagoon which correlates to a loss of 2.6 m^3/d of water (CH2M HILL, March 2002a). Future water content after site remediation has yet to be determined.
11. The current treatment rate of 274 m^3/d is based on the average daily treatment rate for the period of 1984 through 2003 (see Table 2.5). OCWA indicated that when the ATP is operational, it generally pumps water from the equalization pond at 270-280 L/min (389-403 m^3/d), with a maximum of 300 L/min (432 m^3/d). The rated capacity of the ATP is 477 L/min (687 m^3/d).

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Integrated Cleanup Plan
Industrial Area

Figure 2-11
Current and Future Industrial Area Water Flow Diagram

Additional modelling of the groundwater flow from the GIWN will be required, following completion of the additional hydrogeologic field investigations, to better estimate the future flow rates to the ATP.

It is anticipated that the existing groundwater collection and treatment system will continue in operation following completion of the planned rehabilitation program. Therefore, the decommissioning of the existing collection and treatment system is not specifically addressed as part of this ICP.

2.1.5 Implementation Schedule

The implementation schedule (five-year schedule) for the recommended alternative for the Industrial Area is presented in Figure 2-12A. The implementation schedule could also be condensed to three years as shown in Figure 2-12B. The condensed program would require several work crews working simultaneously.

2.2 Mine Area Closure Plan

2.2.1 Overview of Recommended Alternative

The recommended alternative for the Mine Area, consistent with site closure objectives, contains the following key components:

- Increase pumping from Tuttle Shaft (year-round)
- Cover waste rock with geofabric filter, clay, topsoil, and then vegetate (Main and Remote Mine Areas)
- Excavate selected areas containing radioactive slag, HLW/soil, and/or unacceptable SSRA risks, fill excavations, and then vegetate (Main and Remote Mine Areas)
- Cover selected areas containing MLS and/or unacceptable SSRA risks with a simple earth (clay) cap consisting of topsoil, “clean” fill material, and compacted clay, and then vegetate (Main Mine Area)

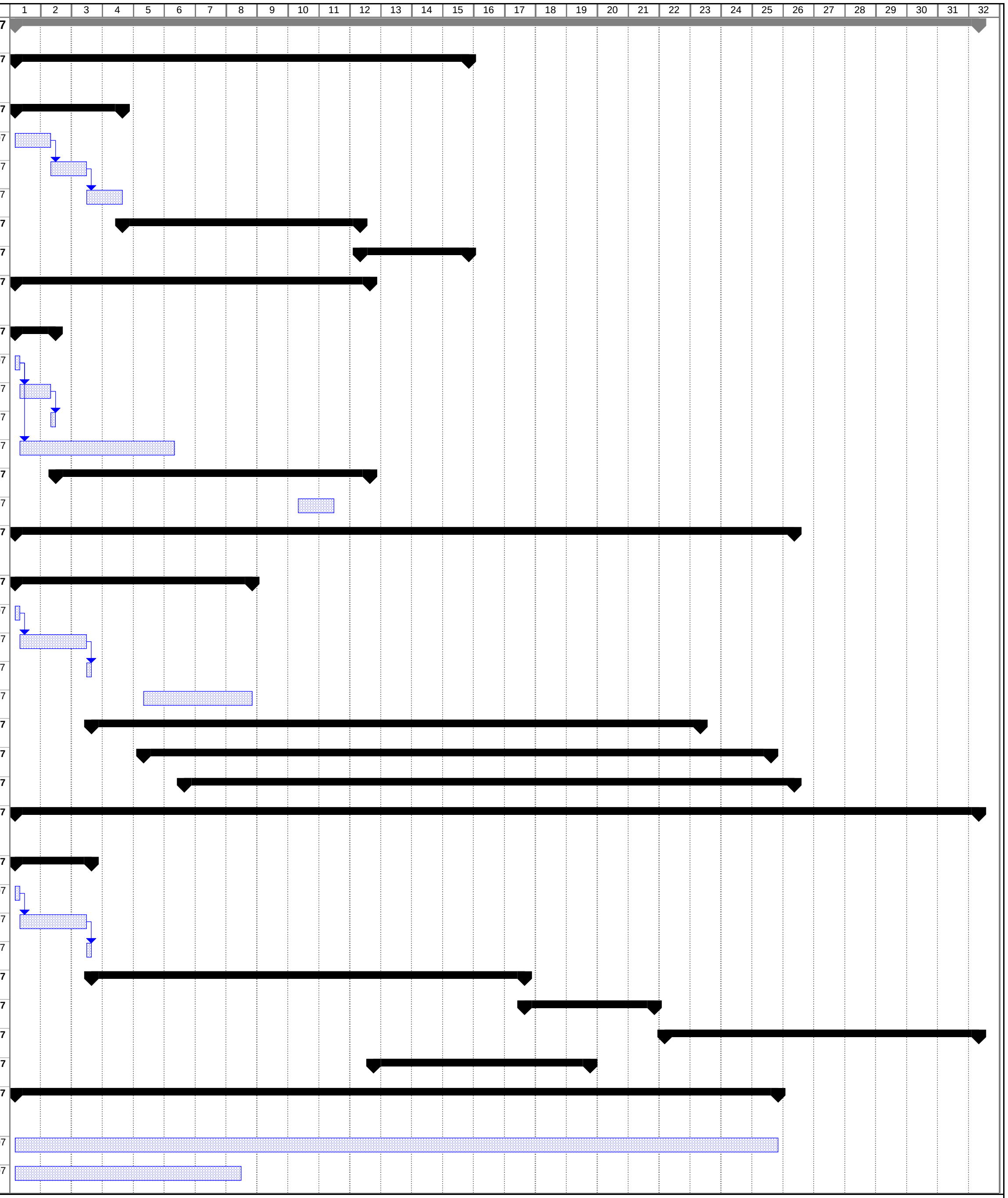
2.2.2 Cleanup Approach and Extent

The proposed cleanup approach is presented in Figure 2-13. The extent of the cleanup is based on the same rationale used in the Industrial Area (Section 2.1.2). The approximate surface water runoff and seepage infiltration flowpaths under pre-closure conditions for the Main Mine Area and Remote Mine Areas are shown in Figure 2-13A. The approximate surface water runoff flowpaths under post-closure conditions for the Main Mine Area and Remote Mine Areas are shown in Figure 2-13B.

2.2.3 Summary of Work Packages

The work packages associated with the recommended alternative for the Mine Area are listed in Table 2.6.

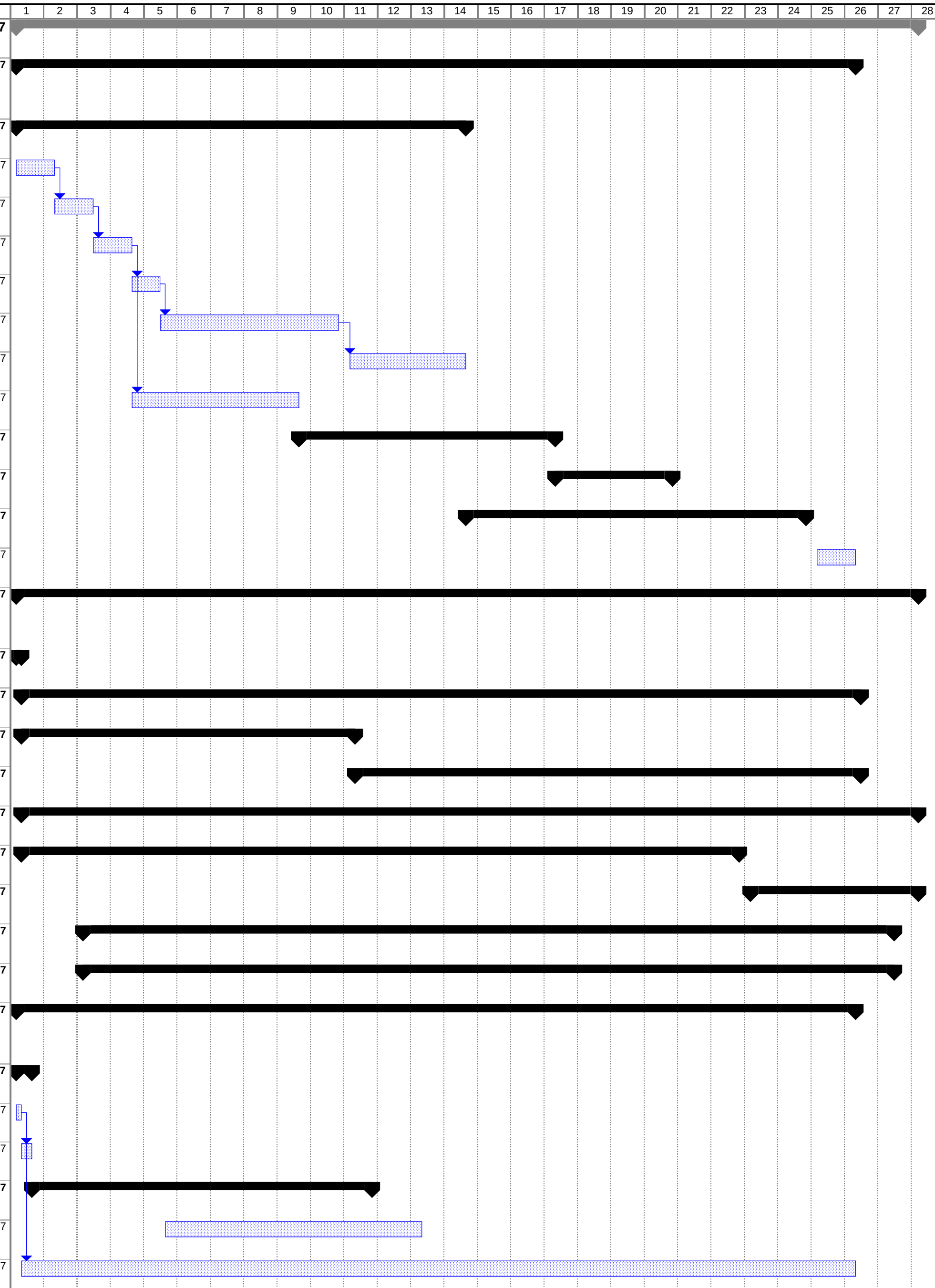
ID	Task Name	Duration	Start
0	**Figure 2-12A - Industrial Area 5-Year Implementation Schedule**	**125 days**	**Mon 04/02/07**
1	**YEAR 1 - Site Preparation and Demolition**	**60 days**	**Mon 04/02/07**
2	**IA-WP#1.1 - Year 1 Site Preparation**	**15 days**	**Mon 04/02/07**
3	1.1.1 - Setup	5 days	Mon 04/02/07
4	1.1.2 - Decontamination Pad	5 days	Tue 04/10/07
5	1.1.3 - Access Routes	5 days	Wed 04/18/07
6	**IA-WP#2.1 - Demolition of Buildings and Tanks**	**30 days**	**Thu 04/26/07**
15	**IA-WP#2.2 - Resizing and Consolidation of Ruins**	**15 days**	**Tue 06/19/07**
25	**YEAR 2 - Riverbank Reconstruction**	**47 days**	**Mon 04/02/07**
26	**IA-WP#1.2 - Year 2 Site Preparation**	**6 days**	**Mon 04/02/07**
27	1.2.1 - Setup	1 day	Mon 04/02/07
28	1.2.2 - Grubbing Trees and Vegetation in Cover and Riverbank Areas	4 days	Tue 04/03/07
29	1.2.3 - Well Decommissioning adjacent Riverbank and Year 2 Cover Areas	1 day	Tue 04/10/07
30	**IA-WP#6.1 - Clay Berm Around Perimeter of Equalization Pond - 20 m/day**	20 days	Tue 04/03/07
31	**IA-WP#3 - Riverbank Reconstruction**	**41 days**	**Wed 04/11/07**
42	**IA-WP#6.2 - 50 cm Clay Cover over Riverbank Wastes - 600 m2/day**	5 days	Tue 06/05/07
43	**YEAR 3 - North Industrial Area Rehabilitation**	**101.5 days**	**Mon 04/02/07**
44	**IA-WP#1.3 - Year 3 Site Preparation**	**32 days**	**Mon 04/02/07**
45	1.3.1 - Setup	1 day	Mon 04/02/07
46	1.3.2 - Grubbing Trees and Vegetation in Cover and North Industrial Areas	9 days	Tue 04/03/07
47	1.3.3 - Well Decommissioning in North Industrial Area and Year 3 Cover Areas	1 day	Wed 04/18/07
48	1.3.4 - New Westerly Creek 500 m Culvert Extension	15 days	Tue 05/01/07
49	**IA-WP#4.1 - Consolidation of North Industrial Area Wastes - 1300 m3/day**	**78 days**	**Thu 04/19/07**
69	**IA-WP#6.3 - 50 cm Clay Cover over NIA Wastes - 1000 m2/day**	**81.5 days**	**Tue 05/01/07**
75	**IA-WP#5.1 - Simple Earth Cap Placement - 1000 m2/day**	**78.5 days**	**Thu 05/10/07**
82	**YEAR 4 - South Industrial Area Rehabilitation**	**125 days**	**Mon 04/02/07**
83	**IA-WP#1.4 - Year 4 Site Preparation**	**11 days**	**Mon 04/02/07**
84	1.4.1 - Setup	1 day	Mon 04/02/07
85	1.4.2 - Grubbing Trees and Vegetation in Cover and South Industrial Areas	9 days	Tue 04/03/07
86	1.4.3 - Well Decommissioning in South Industrial Area	1 day	Wed 04/18/07
87	**IA-WP#4.2 - Consolidate South Industrial Area Wastes - 1300 m3/day**	**56 days**	**Thu 04/19/07**
96	**IA-WP#6.4 - 50 cm Clay Cover over SIA Wastes - 1000 m2/day**	**17 days**	**Thu 07/26/07**
99	**IA-WP#6.5 - Place Remaining Layers of Engineered Cover**	**41 days**	**Mon 08/27/07**
104	**IA-WP#5.2 - Simple Earth Cap Placement - 1000 m2/day**	**28 days**	**Fri 06/22/07**
110	**YEAR 5 - GIWN & Revegetation**	**100 days**	**Mon 04/02/07**
111	**IA-WP#7 - Groundwater Interceptor Well Network**	100 days	Mon 04/02/07
112	**IA-WP#8 - Site Revegetation**	30 days	Mon 04/02/07



Project: Figure 2-12A - Industrial Area 5-Year Implementation Schedule
Date: Thu 11/04/04

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

ID	Task Name	Duration	Start	Finish
0	**Figure 2-12B - Industrial Area 3-Year Implementation Schedule**	**108.5 days**	**Mon 04/02/07**	**Mon 10/08/07**
1	**YEAR 1 - Site Preparation and Demolition**	**101 days**	**Mon 04/02/07**	**Tue 09/25/07**
2	**IA-WP#1.1 - Year 1 Site Preparation**	**55 days**	**Mon 04/02/07**	**Thu 07/05/07**
3	1.1.1 - Setup	5 days	Mon 04/02/07	Tue 04/10/07
4	1.1.2 - Decontamination Pad	5 days	Tue 04/10/07	Wed 04/18/07
5	1.1.3 - Access Routes	5 days	Wed 04/18/07	Thu 04/26/07
6	1.1.4 - Well Decommissioning	3 days	Thu 04/26/07	Wed 05/02/07
7	1.1.5 - Grubbing Trees and Vegetation in Industrial Area	22 days	Wed 05/02/07	Fri 06/08/07
8	1.1.6 - New Westerly Creek 500 m Culvert Extension	15 days	Mon 06/11/07	Thu 07/05/07
9	**IA-WP#6.1 - Clay Berm Around Perimeter of Equalization Pond - 20 m/day**	20 days	Thu 04/26/07	Thu 05/31/07
10	**IA-WP#2.1 - Demolition of Buildings and Tanks**	**30 days**	**Thu 05/31/07**	**Tue 07/24/07**
19	**IA-WP#2.2 - Resizing and Consolidation of Ruins**	**15 days**	**Tue 07/24/07**	**Fri 08/17/07**
29	**IA-WP#3 - Riverbank Reconstruction**	**41 days**	**Thu 07/05/07**	**Fri 09/14/07**
40	**IA-WP#6.2 - 50 cm Clay Cover over Riverbank Wastes - 600 m2/day**	5 days	Mon 09/17/07	Tue 09/25/07
41	**YEAR 2 - Waste Consolidation and Simple Earth Cap**	**108.5 days**	**Mon 04/02/07**	**Mon 10/08/07**
42	**IA-WP#1.2 - Year 2 Site Preparation**	**1 day**	**Mon 04/02/07**	**Tue 04/03/07**
44	**CREW 1**	**101 days**	**Tue 04/03/07**	**Wed 09/26/07**
45	**IA-WP#4.1 - Consolidation of Industrial Area Wastes - 1300 m3/day**	**40 days**	**Tue 04/03/07**	**Tue 06/12/07**
52	**IA-WP#6.3/6.4 - 50 cm Clay Cover over Wastes - 1000 m2/day**	**61 days**	**Tue 06/12/07**	**Wed 09/26/07**
58	**CREW 2**	**107.5 days**	**Tue 04/03/07**	**Mon 10/08/07**
59	**IA-WP#4.2 - Crew 2 Consolidation of Industrial Area Wastes - 1300 m3/day**	**87 days**	**Tue 04/03/07**	**Fri 08/31/07**
80	**IA-WP#5.1 - Simple Earth Cap Placement - 1000 m2/day**	**20.5 days**	**Mon 09/03/07**	**Mon 10/08/07**
84	**CREW 3**	**98 days**	**Mon 04/16/07**	**Wed 10/03/07**
85	**IA-WP#5.1 - Simple Earth Cap Placement - 1000 m2/day**	**98 days**	**Mon 04/16/07**	**Wed 10/03/07**
95	**YEAR 3 - Cover, GIWN & Revegetation**	**101 days**	**Mon 04/02/07**	**Tue 09/25/07**
96	**IA-WP#1.3 - Year 3 Site Preparation**	**3 days**	**Mon 04/02/07**	**Thu 04/05/07**
97	1.3.1 - Setup	1 day	Mon 04/02/07	Tue 04/03/07
98	1.3.2 - Preparation of Clay Cover	2 days	Tue 04/03/07	Thu 04/05/07
99	**IA-WP#6.5 - Place Remaining Layers of Engineered Cover**	**41 days**	**Thu 04/05/07**	**Fri 06/15/07**
104	**IA-WP#8 - Site Revegetation**	30 days	Thu 05/03/07	Tue 06/26/07
105	**IA-WP#7 - Groundwater Interceptor Well Network**	100 days	Tue 04/03/07	Tue 09/25/07



Project: Figure 2-12B - Industrial Area 3-Year Implementation Schedule
Date: Thu 11/04/04

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

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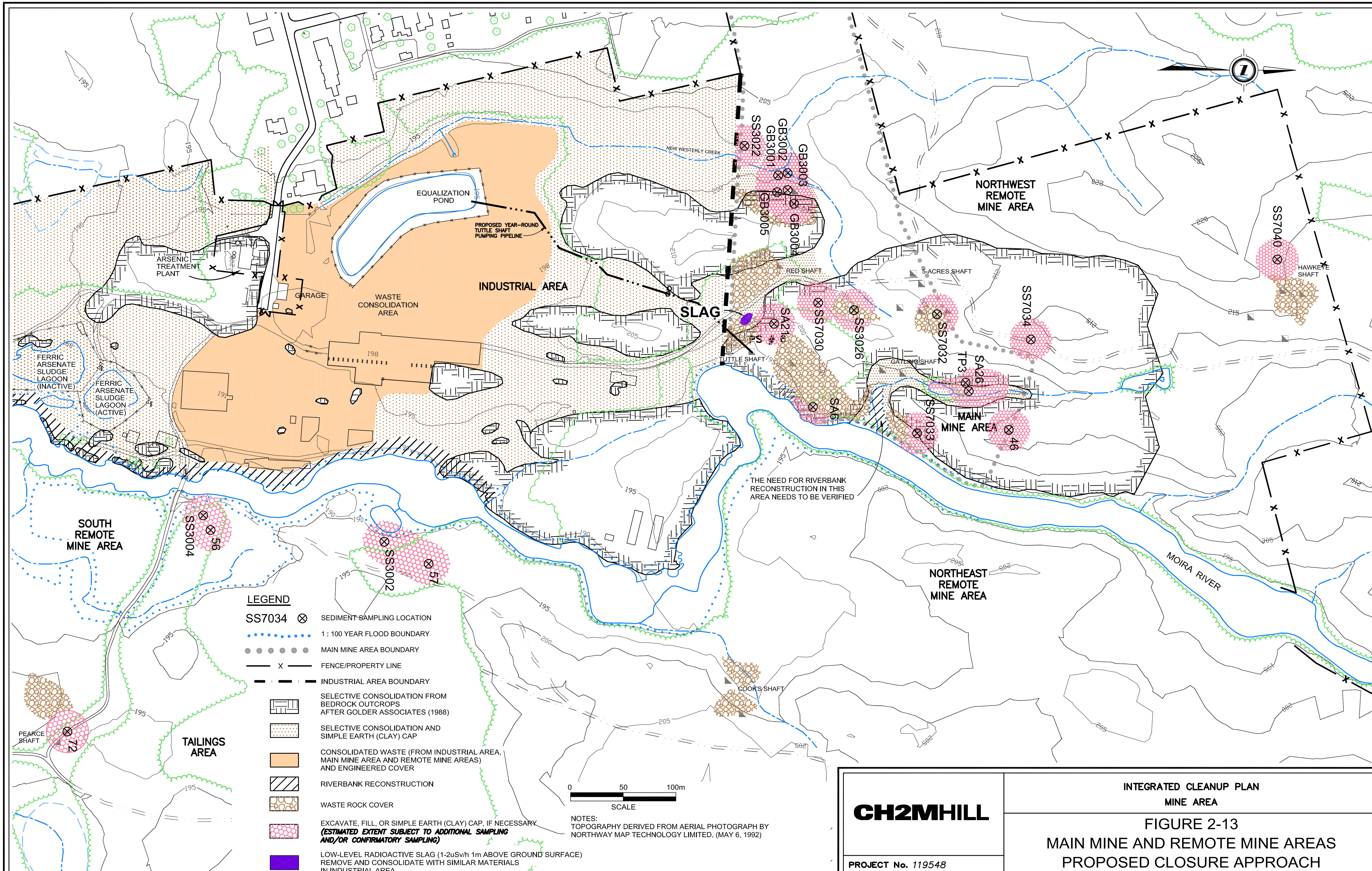

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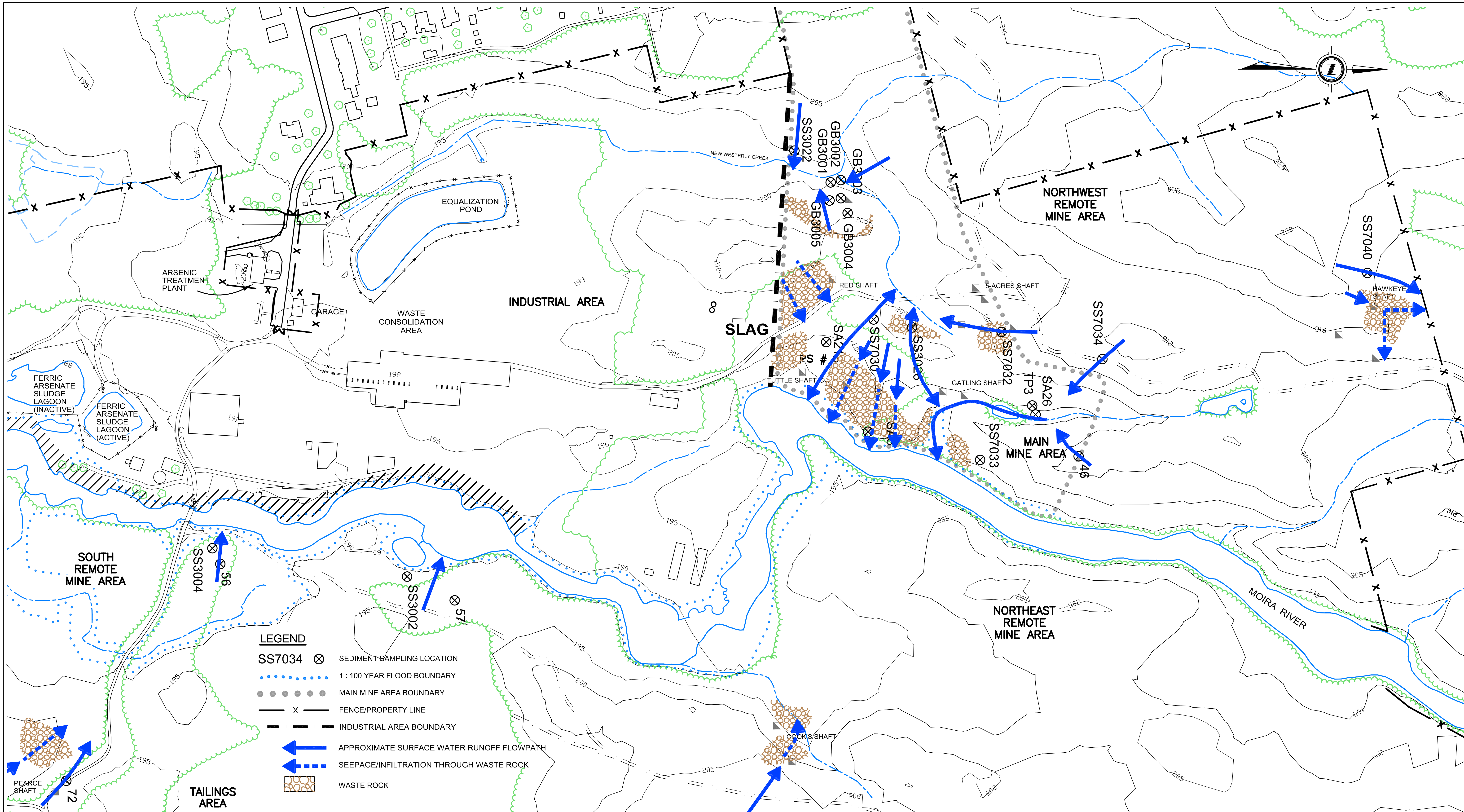

NOTES:
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INTEGRATED CLEANUP PLAN
MINE AREA

FIGURE 2-13A MAIN MINE AREA AND REMOTE MINE AREAS APPROXIMATE SURFACE WATER RUNOFF AND SEEPAGE INFILTRATION FLOWPATHS UNDER PRE-CLOSURE CONDITIONS

PROJECT No. 119548

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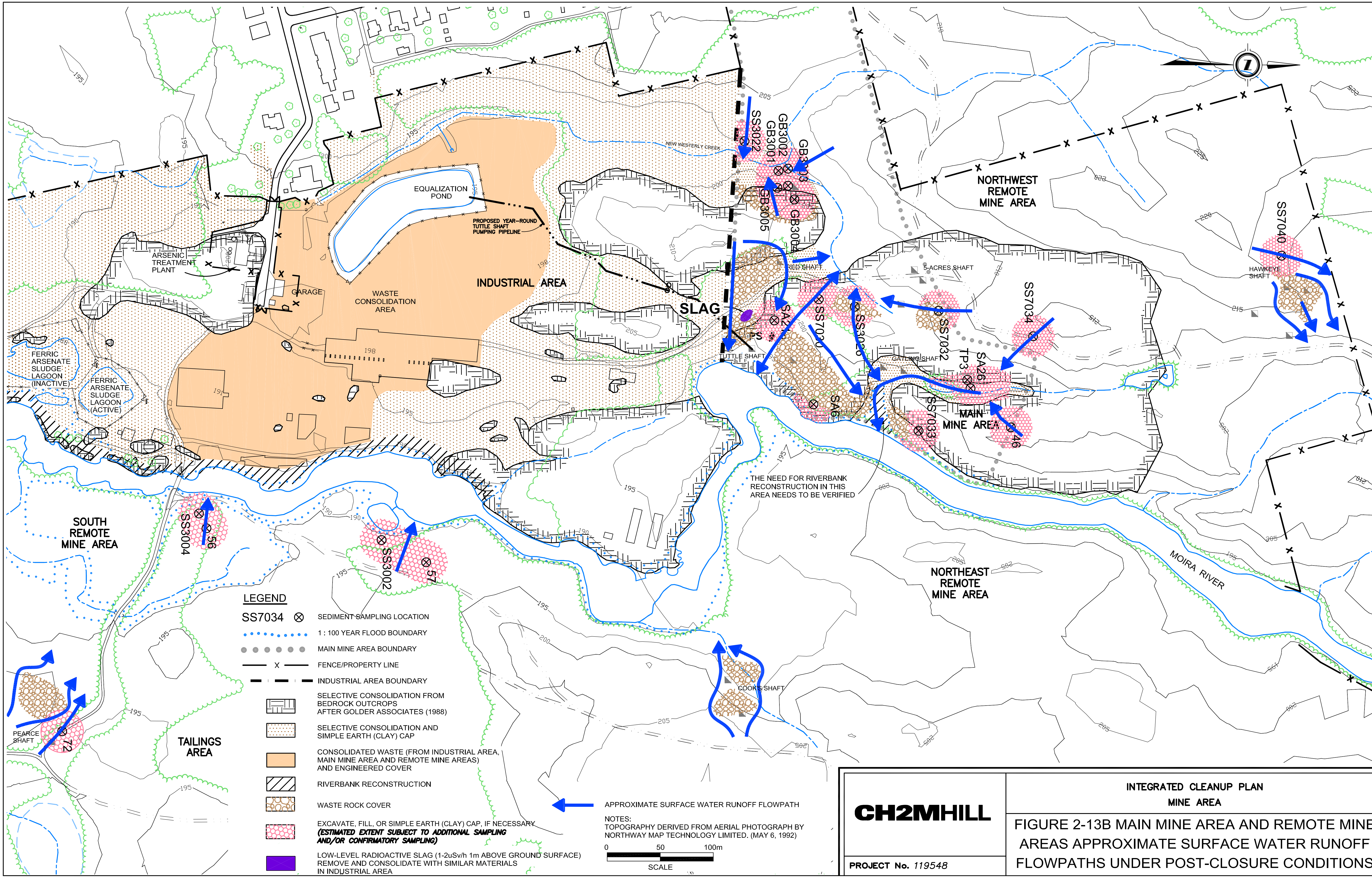

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INTEGRATED CLEANUP PLAN
MINE AREA

FIGURE 2-13B MAIN MINE AREA AND REMOTE MINE AREAS APPROXIMATE SURFACE WATER RUNOFF FLOWPATHS UNDER POST-CLOSURE CONDITIONS

PROJECT No. 119548

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TABLE 2.6
IDENTIFICATION OF MINE AREA WORK PACKAGES

Package I.D.	Work Package Description
MMA-WP#1a	Excavate HLW, Low-Level Radioactive Slag and Infill/Vegetate, and Reconstruct Riverbank (if required)
RMA-WP#1b	Excavate Impacted Soils and Infill/Vegetate
MMA-WP#2a	Cover Waste Rock and MLS and Vegetate
RMA-WP#2b	Cover Waste Rock and Vegetate
MMA-WP#3	Upgrade Tuttle Shaft Pumping System Installation, and Install Overland Piping to Industrial Area

2.2.4 Design Description

Site Preparation

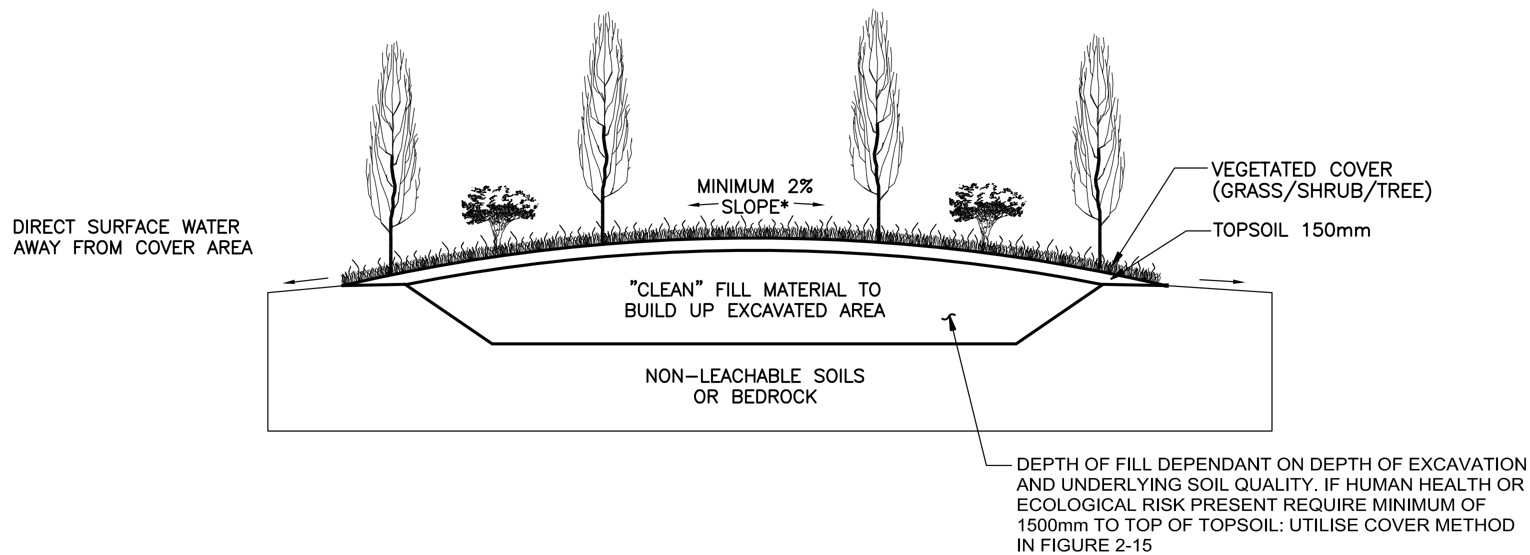
Prior to commencing the remedial work, site preparation work will be completed including mobilization of equipment (excavators, trucks, site trailers, and other equipment), construction of temporary access roads, and establishment of temporary services.

Vegetation and trees of various sizes and maturity cover certain portions of the affected areas. Work in some of these areas will require the clearing and grubbing of the local flora. Clearing and grubbing should be kept to a minimum to preserve the natural condition of the site.

MMA-WP#1a: Excavate Highly Leachable Waste, Low-Level Radioactive Slag and Infill/Vegetate, and Reconstruct Riverbank (if required), and RMA-WP#1b: Excavate Impacted Soils and Infill/Vegetate

Selected areas in the Main Mine Area containing HLW/soil and areas identified in the draft SSRA as posing unacceptable risks, will be excavated (approximately 21,600 m^3, subject to confirmation). To mitigate the potential of leachate from these materials migrating and having offsite impacts, and to eliminate human health and ecological risks, the materials will be excavated and consolidated with other HLW and stored onsite in the Industrial Area, as shown in Figure 2-13. The excavations will be backfilled to grade with appropriate readily available "clean" fill material and compacted to the necessary densities to mitigate differential settlement potential. The fill will be covered with a 0.15-m topsoil layer and vegetated if the soils below and adjacent to the excavation are deemed acceptable for this type of cover, as shown in Figure 2-14. Otherwise, if the remaining soils are found to be marginally leachable, or elevated human health or ecological risks are still present, a simple earth (clay) cap (described below) would be used to cover the excavated and adjacent areas.

In addition, selected soils in the Remote Mine Area (see Figure 2-13) will also be excavated and consolidated in the Industrial Area (approximately 7,800 m^3, subject to confirmation). These soils generally are not highly leachable but pose unacceptable human health or ecological risks. It is anticipated that these areas can be readily excavated and backfilled with "clean" fill material, eliminating the need for simple earth (clay) caps outside of the Main Mine Area that would otherwise require ongoing inspection and maintenance.



*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

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INTEGRATED CLEANUP PLAN
MINE AREA

FIGURE 2-14
COVER METHOD FOR EXCAVATED AREAS OF
IMPACTED SOIL AND/OR CONCENTRATED WASTE

In the Alternatives report for the Mine Area, a cover thickness of 650 mm was selected to provide an infiltration barrier plus a suitable growing medium for plants. However, as a result of the draft SSRA (CH2M HILL, May 2003b), the capping thickness was increased to 1,350 mm for clay/fill materials and 150 mm for topsoil, totalling 1,500 mm. This will reduce the potential for exposure to contaminants by burrowing animals and root penetration as part of the SLERA, as noted in Section 2.1.2. The use of armour rock as an enhancement has been abandoned, as the benefits are no longer valid with this depth of imported material. With exception, the waste rock areas will be covered with a geofabric filter, 500 mm of clay, and 150 mm of topsoil since the contaminants in these areas are not considered bio-available, and burrowing animals and tree roots are not expected to reach the underlying impacted materials.

In the report *Deloro Mine Rehabilitation Project – Extent and Character of Radioactive Materials, Final Report* (CG&S, June 1999), low-level radioactive slag (1 – 2 μSv/h) was noted in an area adjacent to, and west of, the Tuttle Shaft. The volume of this slag is small, likely about 5 m^3 or less. This material will be removed and consolidated with similar materials in the Industrial Area. The excavation will be filled in with "clean" fill material and then capped with a simple earth (clay) cap as per the adjacent waste rock cover approach.

From the current available data, it is not clear if waste rock, HLW, or MLS are within the 100-year flood elevation of the Moira River adjacent to the Main Mine Area. While this will need to be confirmed, an estimated 3,000 m^3 of material has been included in the volume required for consolidation in the Industrial Area. The Moira River bank may be affected, since some of the waste rock and HLW/soil areas may extend down from the 100-year flood elevation to the river's edge (see Figure 2-13). These contaminants may need to be removed (approximately 3,000 m^3, subject to confirmation), and bank stabilization would be required.

About one half of the Main Mine Area could be impacted through capping and grading. Impacted areas will be graded to discourage ponding, reduce infiltration, and promote runoff. A very small amount of the Remote Mine Area will require grading, specifically the waste rock areas and selected areas of excavation, as noted above. Impacted areas will be graded to discourage ponding, reduce infiltration, and promote runoff.

Following the completion of site rehabilitation measures (i.e. surface water control features, waste excavation and consolidation, cover/cap placement, site grading), the Main Mine Area and selected Remote Mine Areas will be landscaped to suit the intended final use and seeded with a mixture of grasses in order to stabilize the surface and limit erosion. The cover/cap will also be vegetated with trees and shrubs to increase the evapotranspiration capability of the cover/cap.

A watercourse north of the Gatling Shaft will either be excavated and reinstated in the original position, or relocated to reduce the potential for eroding the freshly placed soils and vegetation. Bioengineering and/or erosion protection using geosynthetic fabric and/or rip/rap will be required.

MMA-WP #2a: Cover Waste Rock and Marginally Leachable Soil and Vegetate, and RMA-WP#2b: Cover Waste Rock and Vegetate

There are three areas, as shown in Figure 2-13, that are identified as areas that may require selective consolidation and a simple earth (clay) cap. The two areas adjacent to the Industrial Area are extensions of similar areas within the Industrial Area. While there are no

sampling results to indicate that these areas are of concern, they are adjacent to areas of concern and should, therefore, be included in the same testing program as will occur in the Industrial Area. The area shown for selective consolidation and simple earth (clay) cap in the vicinity of the Gatling Shaft is considered a high likelihood area for arsenic contamination since it is downgradient of the former arsenic dump area. Therefore, soil testing should be carried out to determine if this assumption is correct or not.

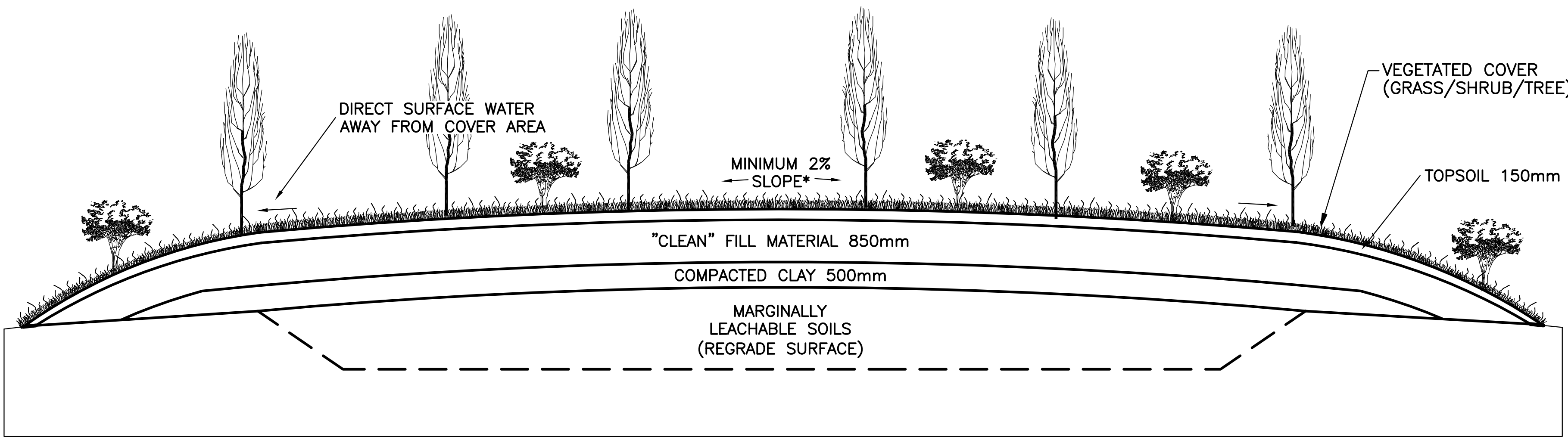
The recommended choice of cover for the identified MLS in the Main Mine Area consists of layers of topsoil, fill, and compacted clay materials, as illustrated in Figure 2-15. The topsoil provides the initial rooting medium for the cover vegetation, as well as some water storage capacity that will increase the effectiveness of the evapotranspiration properties of the vegetation. The fill material provides rooting medium of sufficient depth that root penetration and burrowing animals will not easily become exposed to the underlying MLS. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying materials. Further design effort, material availability, quality, and cost will determine the materials of construction and their sources.

Accumulations of waste rock from historical mine activities have been identified in both the Main and Remote Mine Areas (see Figure 2-13). The recommended alternative includes isolating the waste rock from the surrounding environment to mitigate its leaching potential and to reduce the likelihood of human contact. The first step will be to regrade the waste rock with heavy machinery so that stormwater and melt runoff will be directed away from the covered waste rock. The regraded piles will be covered with a geofabric filter to minimize differential settlement and to simplify the installation of cover materials. Clay will then be used to cover the geofabric filter to a depth of 0.5 m to act as a low-permeability barrier. The clay will be compacted to the necessary density to optimize the low-permeability characteristics of this material. Vegetation and trees will be planted in a 0.15 m topsoil layer, placed above the clay layer to blend with existing conditions adjacent to the affected area and graded to promote stormwater runoff. The total depth of the cover material will be a minimum of 0.65 m. The cover method for waste rock is shown in Figure 2-16.

MMA-WP #3: Upgrade Tuttle Shaft Pumping System Installation, and Install Overland Piping to Industrial Area

Groundwater collected in the Tuttle Shaft will be extracted on a year-round basis and treated in the onsite ATP. The Tuttle Shaft currently flows by gravity under artesian conditions to the Moira River, typically for nine months of the year. However, observations by OCWA staff have confirmed that the flow continues year-round (personal communication OCWA, March 2004). A flow rate of 135 L/min (195 m^3/d) was measured during 1997 field investigations completed by CH2M HILL (*Development of a Sitewide Water and Load Balance, Final Report* CH2M HILL, March 2002a). Based on the 195 m^3/d reference rate, the maximum possible volume per year would be on the order of 71,175 m^3, assuming water could be drawn for 12 months per year. At this time, the Tuttle Shaft pump is only operated during low-flow conditions in the Moira River, which typically extends for two to five months during the Summer and Fall. Pump operation is dependent on Moira River water quality impacts by the Tuttle Shaft discharge.

23/AUG/2004



*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

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PROJECT No. 119548

INTEGRATED CLEANUP PLAN
MINE AREA

FIGURE 2-15 : COVER METHOD (SIMPLE EARTH [CLAY] CAP) FOR NON-EXCAVATED AREAS OF IMPACTED SOIL AND/OR CONCENTRATED WASTE

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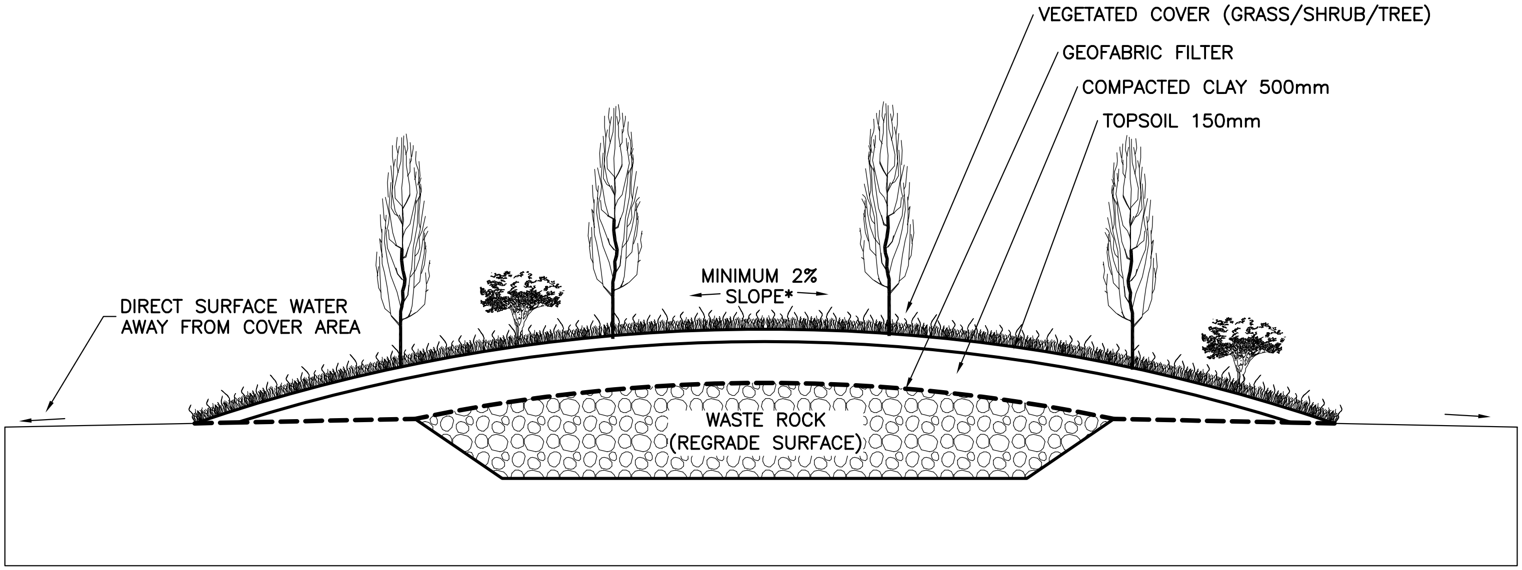

*NOTE:
SURFACE WATER TO BE CONVEYED TO MINIMIZE INFILTRATION POTENTIAL.
CLAY MUST BE COMPACTED AND MOUNDED ABOVE GRADE TO ALLOW FOR SETTLEMENT.
MUST ALSO BE CONSISTENT WITH SITE GRADES.
N.T.S.

CH2MHILL	INTEGRATED CLEANUP PLAN MINE AREA
	FIGURE 2-16 COVER METHOD (CLAY CAP) FOR WASTE ROCK
PROJECT No. 119548	

Annual water taking records from OCWA from 2000 to 2003 indicate that the annual average withdrawal is 13,316 m^3/yr. Table 2.7 summarizes the Tuttle Shaft pumping rates from 2000 to 2003. OCWA indicates that the Tuttle Shaft has a FLYGT Model #2052 pump with a 1.6-hp, 220-volt motor. OCWA's annual water taking records indicate that the Tuttle Shaft pump capacity is 6.05 L/s (523 m^3/d). Accordingly, the capacity of the existing pump is anticipated to be sufficient to draw more than the quantity of water naturally flowing under artesian conditions.

TABLE 2.7
SUMMARY OF TUTTLE SHAFT PUMPING RATES

Year	Number of Months Pumped	Months Pumped	Total Volume (m^3)	Maximum Pumping Rate (m^3/month)
2000	2	Sep., Oct.	9,916	6,649.4
2001	4	Jul., Aug., Sep., Oct.	13,730	4,412.6
2002	5	Jul., Aug., Sep., Oct., Nov.	16,720	7,557.7
2003	3	Jul., Aug., Sep.	12,900	6,671.2
Average			13,316	

Data from OCWA's Annual Record of Water Taking for the Tuttle Shaft (Pumping Station No. 6) from 2000 to 2003.

A new, more durable pump may need to be purchased and installed depending on the condition and age of the existing pump. A new pipeline from the Tuttle Shaft to the equalization pond will be mounted on an overhead pipe rack to allow easier access to the pipeline in case of leakage. This will minimize the potential for compromising the integrity of the engineered and simple earth (clay) cap in the Industrial Area, as could occur during pipe failure if the pipe were to be buried. Heat tracing will be installed onto the full length of the pipe along with insulation and cladding to prevent pipe freeze-up during colder periods. The design of this system would need to be compatible with short- and long-term requirements in the Industrial Area.

2.2.5 Implementation Schedule

The implementation schedule for the recommended alternative for the Mine Area is presented in Figure 2-17.

2.3 Tailings Area Closure Plan

2.3.1 Overview of Recommended Alternative

The recommended alternative for the Tailings Area, consistent with site closure objectives is as follows:

- To cover the surface of the existing crushed limestone cap with an engineered soil cover and vegetation (hybrid poplar trees are expected to provide the greatest benefit)

Figure 2-17
Mine Area Closure Plan Implementation Schedule

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		Year 1				Year 2			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation								
MMA-WP#1a	**Excavation and removal of the waste materials and low-level radioactive slag; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating, including reconstructing a portion of the Moira River bank (if required).**								
RMA-WP#1b	**Excavation and removal of soils; infilling of the excavations to grade with "clean" fill material and topsoil; then vegetating**								
MMA-WP#2a	**Regrading and covering of waste rock with geofabric filter; covering with clay (compacted) and topsoil; then vegetating. Consolidating and covering the marginally leachable soil areas with clay (compacted), "clean" fill material, topsoil, and then vegetating**								
RMA-WP#2b	**Regrading and covering waste rock with geofabric filter, clay (compacted), and topsoil, and then vegetating**								
MMA-WP#3	**Install pump and overland piping in year following the completion of the Industrial Area closure between the Tuttle Shaft and the equalization pond**								

- Collection and pumping of contaminated seepage and groundwater associated with the tailings impoundment for treatment
- Construction of an interceptor ditch to divert unimpacted surface water runoff away from the Tailings Area

These features are shown in Figure 2-18. The approximate surface water runoff flowpaths for the Tailings Area and vicinity under pre-closure conditions are shown in Figure 2-18A. The approximate surface water runoff flowpaths for the Tailings Area and vicinity under post-closure conditions are shown in Figure 2-18B.

For a period of four to seven years (during which the hybrid poplars are expected to reach maturity), it is expected that the contaminated seepage and groundwater from the Tailings Area will be directed to the equalization pond located in the Industrial Area via a collection and pumping system for treatment. This is consistent with previous work (Geocon, 1986) that recognizes the compatibility of this approach to the surrounding environment, while effectively providing contaminant loading reduction to the Moira River and Young's Creek.

The possibility exists that the pumping operation might be phased out with time as the water infiltration control measures (i.e. poplar trees and clay cap) take effect and seepage production and loading becomes negligible. Alternatively, if the seepage volume and contaminant loading reduce significantly but still require moderate treatment, a natural wetland treatment system can be installed to provide long-term passive water quality improvement. This is supportive of the site-wide closure objective of minimizing perpetual operation and maintenance.

2.3.2 Cleanup Approach and Extent

The proposed cleanup approach is presented in Figure 2-18. The extent of the cleanup is based on the same rationale used in the Industrial Area (Section 2.1.2).

2.3.3 Summary of Work Packages

The work packages associated with the recommended alternative for the Tailings Area are listed in Table 2.8.

TABLE 2.8
IDENTIFICATION OF TAILINGS AREA WORK PACKAGES

Package I.D.	Work Package Description
TA-WP#1	Site Preparation
TA-WP#2	Place Rip/Rap and Geotextile
TA-WP#3a	Install Engineered Cap, Interceptor Ditch and Drainage Ditches, and Plant the Surface with Grass
TA-WP#3b	Install Irrigation System and Poplar Tree Plantation
TA-WP#4	Drill Seepage/Groundwater Collection Wells, and Install Power Supply, Pumps, Heated Enclosures and Overland Piping to the Industrial Area

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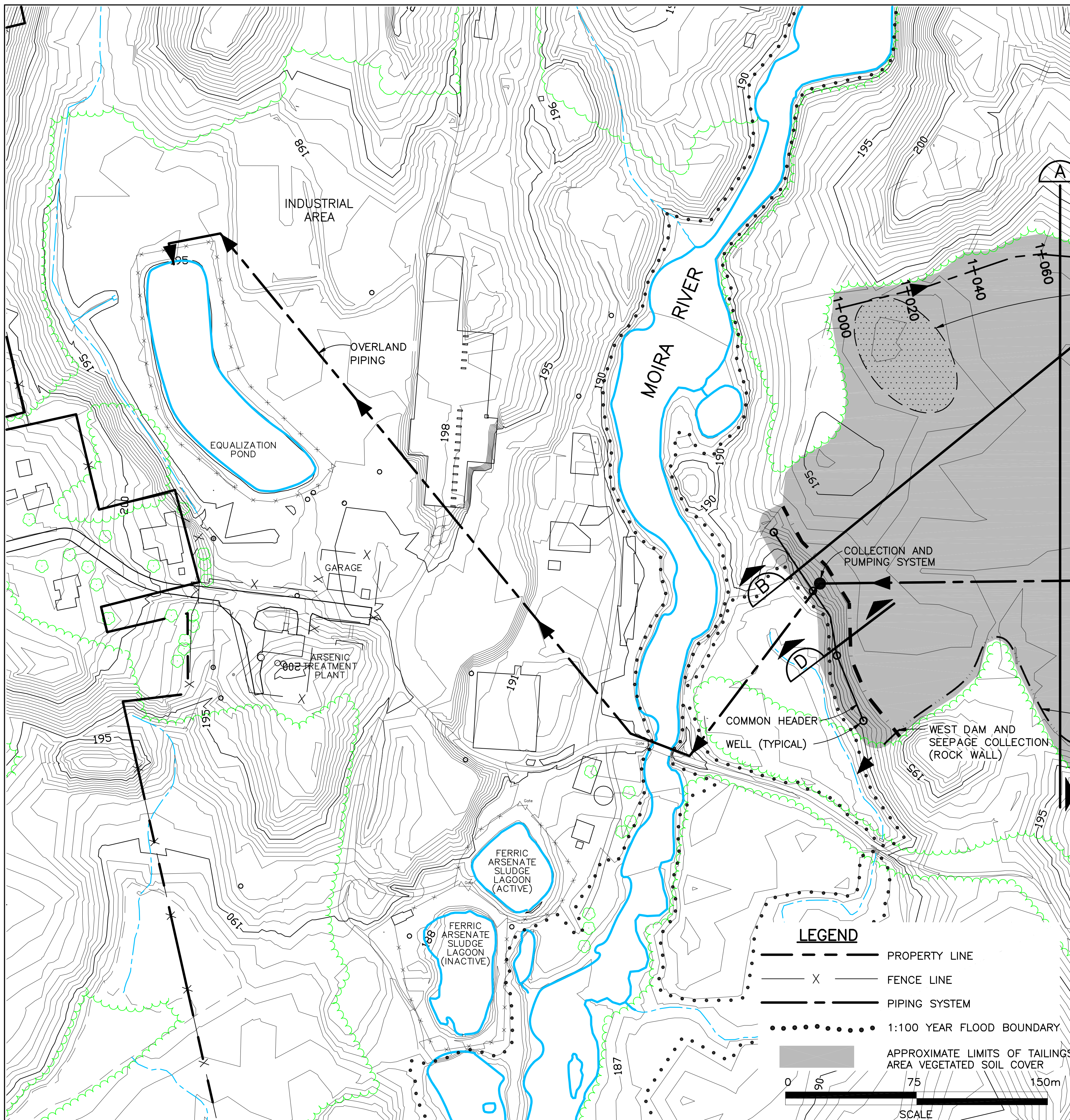

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INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-18: CONCEPTUAL PLAN OF THE PROPOSED TAILINGS AREA VEGETATED ENGINEERED SOIL COVER WITH INTERCEPTOR DITCH AND TREATMENT OF SEEPAGE AT ARSENIC TREATMENT PLANT

PROJECT No. 119548

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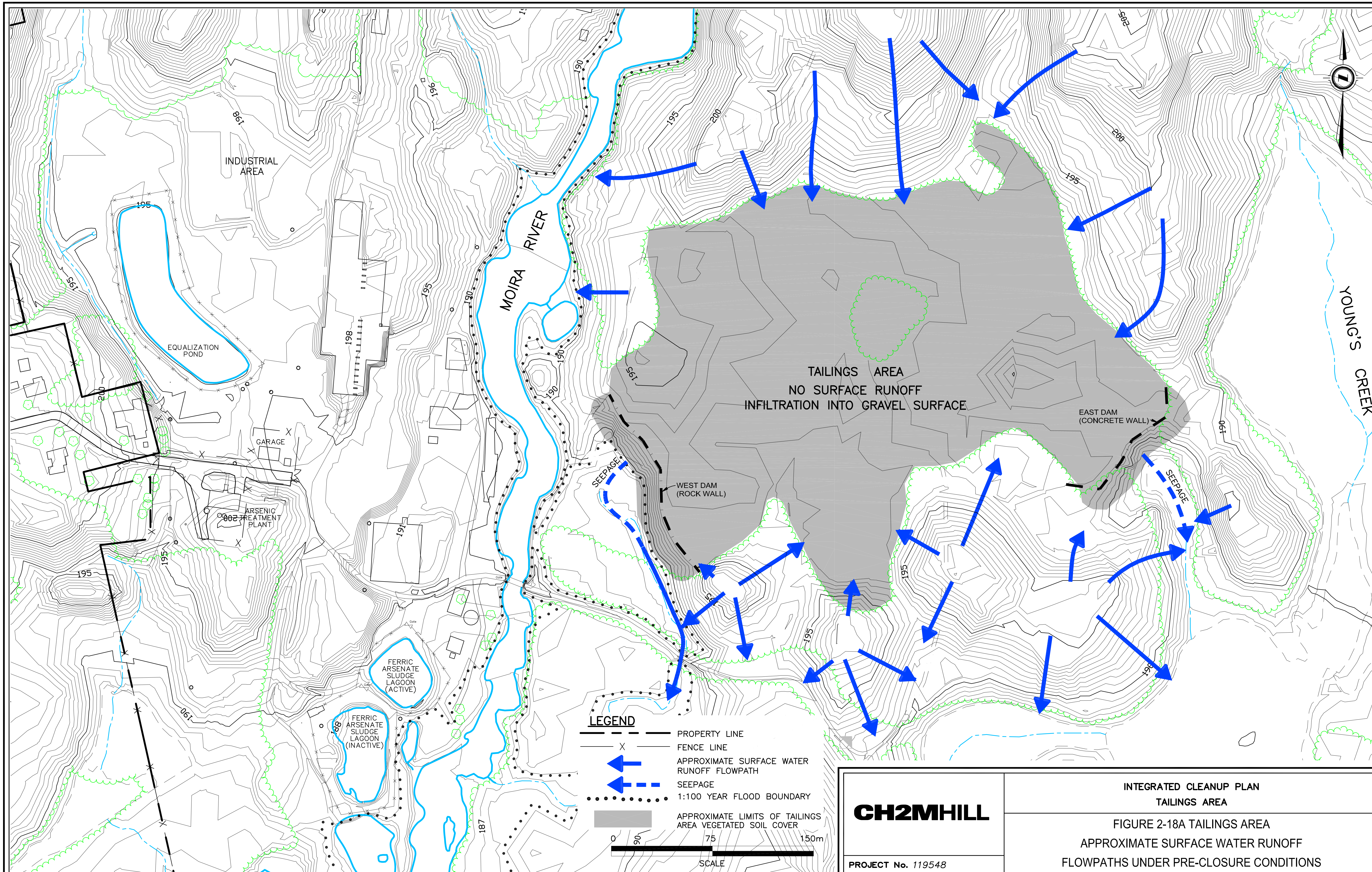

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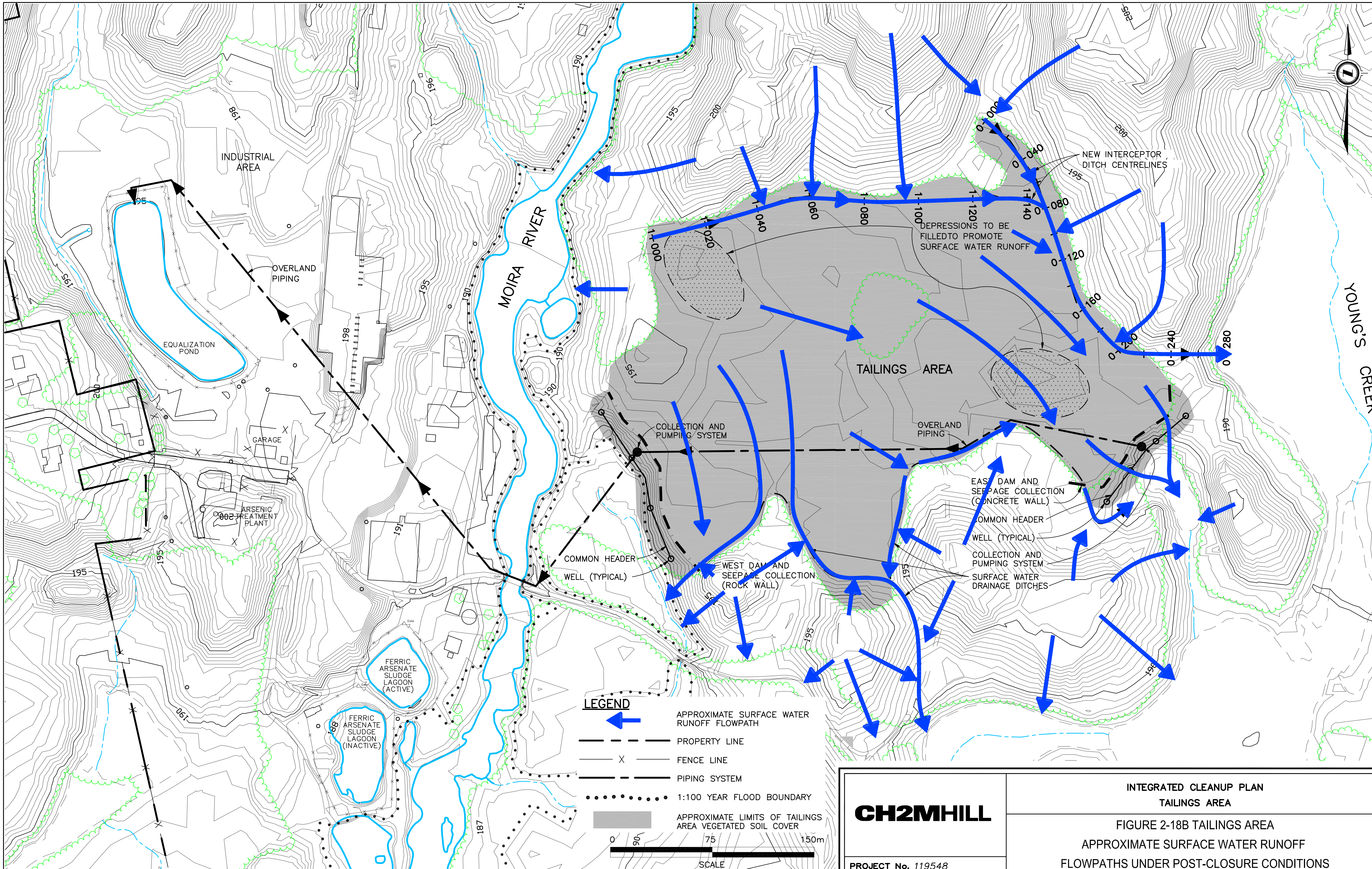

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INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-18B TAILINGS AREA
APPROXIMATE SURFACE WATER RUNOFF
FLOWPATHS UNDER POST-CLOSURE CONDITIONS

PROJECT No. 119548

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2.3.4 Design Description

TA-WP#1: Site Preparation

Site preparation activities will include Contractor set-up, preparation of access routes, construction of a washpad and mobile washer, installation of surface water control items, and temporary road construction to the Tailings Area. Clearing and grubbing along the perimeter of the Tailings Area will be necessary, especially along the northern edge to allow for placement of and grading for the interceptor ditch. Clearing and grubbing to remove trees from the tailings surface and from the rock outcroppings within the Tailings Area will also be undertaken.

TA-WP#2: Place Rip/Rap and Geotextile

Rip/rap and geotextile will be placed at the toe of the east and west tailings dam walls, as shown in Figures 2-19 and 2-20. Geotextile will be also be installed along the slope of the crushed limestone berm portion of the two dam walls and over the limestone cover of the Tailings Area.

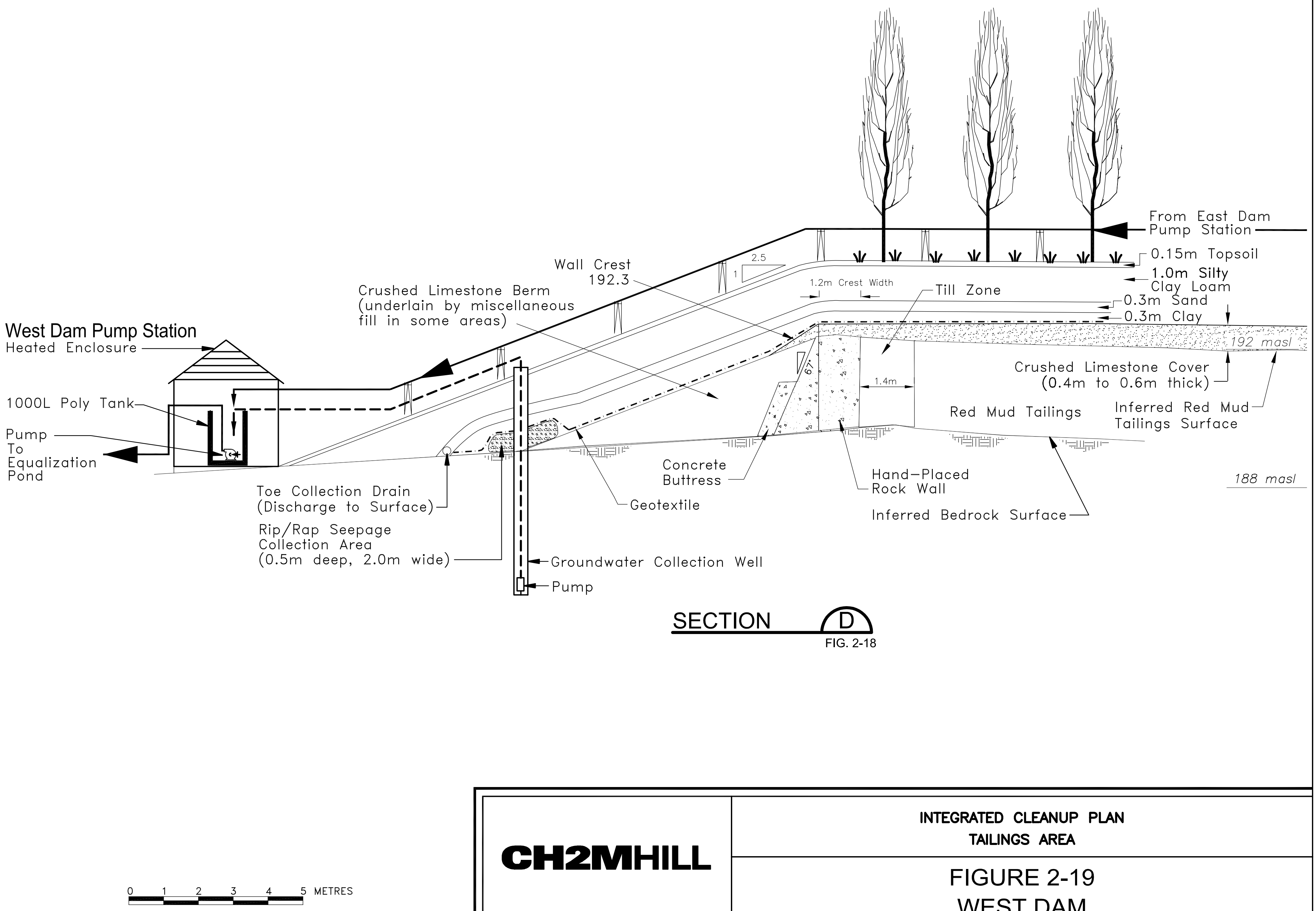
TA-WP#3a and 3b: Install Engineered Cap, Interceptor Ditch and Drainage Ditches, and Plant Grass and Install Irrigation System and Poplar Tree Plantation

The preferred choice of the engineered soil cover consists of a layer of silty clay loam in combination with topsoil, sand, perforated HDPE collection pipe, and compacted clay materials. A geotextile filter would separate the cover soils from the crushed limestone. Figures 2-21 and 2-22 present cross-sections of the Tailings Area showing the proposed cover. Depressions will require filling to promote surface water runoff, as shown in Figure 2-18. The topsoil provides the initial rooting medium for the hybrid poplar trees, while the silty clay loam and sand provide the necessary water storage capacity that will increase the effectiveness of the poplar trees. The compacted clay layer functions as a low-permeability layer to minimize percolation of water into the underlying limestone cover and tailings (red mud).

An irrigation system will be installed and operated for a period of approximately three years during the maturation of the hybrid poplar tree plantation.

Although the use of an engineered soil cover and hybrid poplar plantation is predicted to be effective in reducing the infiltration and deep percolation of water, an interceptor ditch is also recommended to achieve a greater level of water inflow reduction. The advantages of an interceptor ditch include a reduction of the surface water flow into the Tailings Area and an expected reduction of the influx of contaminants into the Moira River and Young's Creek.

An effective interceptor ditch could be constructed along the north and east side of the Tailings Area, where reduction in the effective catchment area can be achieved. The unimpacted surface water runoff (i.e. stormwater) would be diverted to Young's Creek via the interceptor ditch. Surface water runoff from the capped tailings will be diverted by ditches to low-lying areas south of the Tailings Area. Figure 2-18 presents the conceptual approach to surface and stormwater management. Figure 2-23 presents a cross-section of the proposed stormwater interceptor ditch.



SECTION D
FIG. 2-18

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INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-19
WEST DAM
COVER PLACEMENT

PROJECT No. 119548

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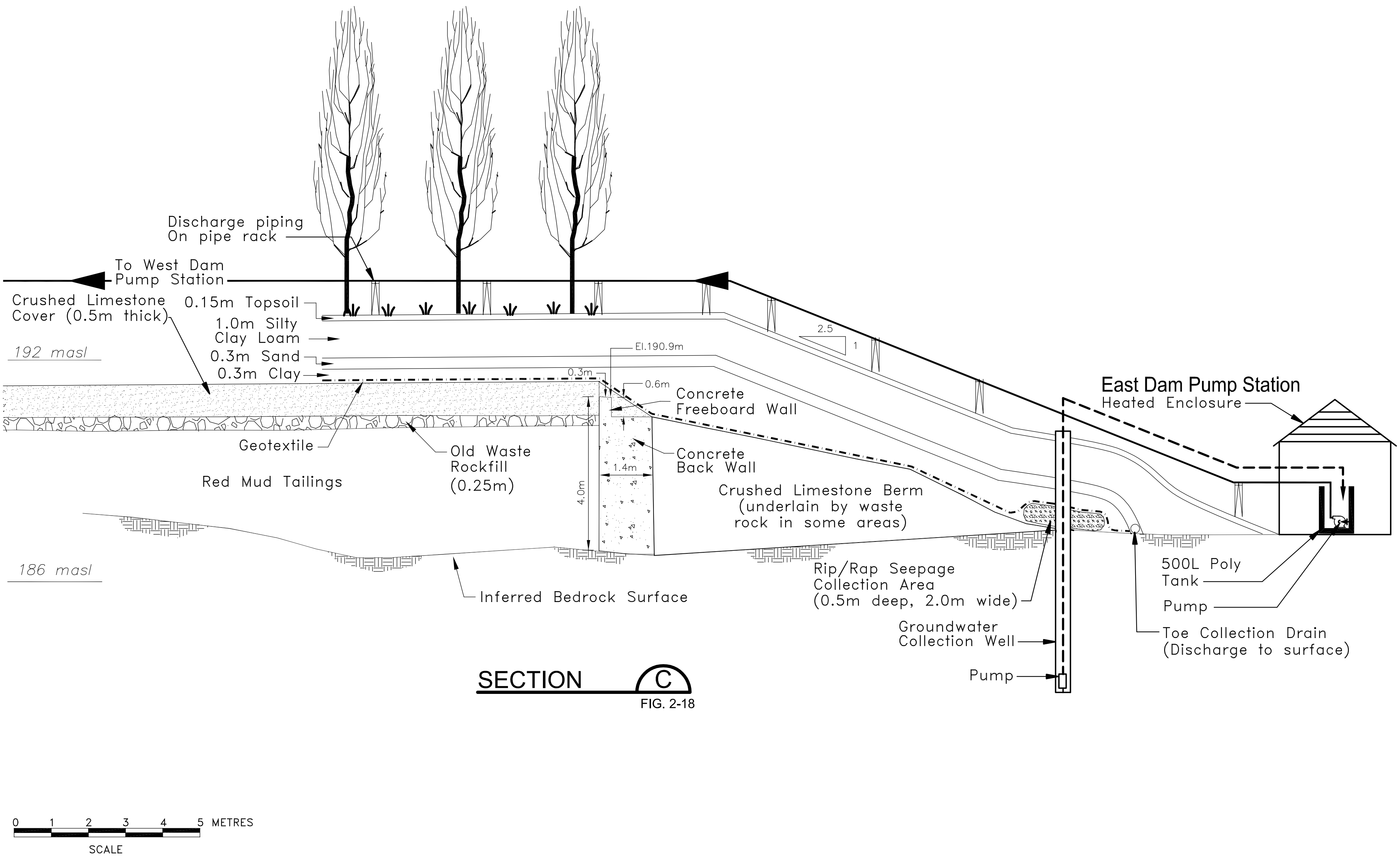

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INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-20
EAST DAM
COVER PLACEMENT

PROJECT No. 119548

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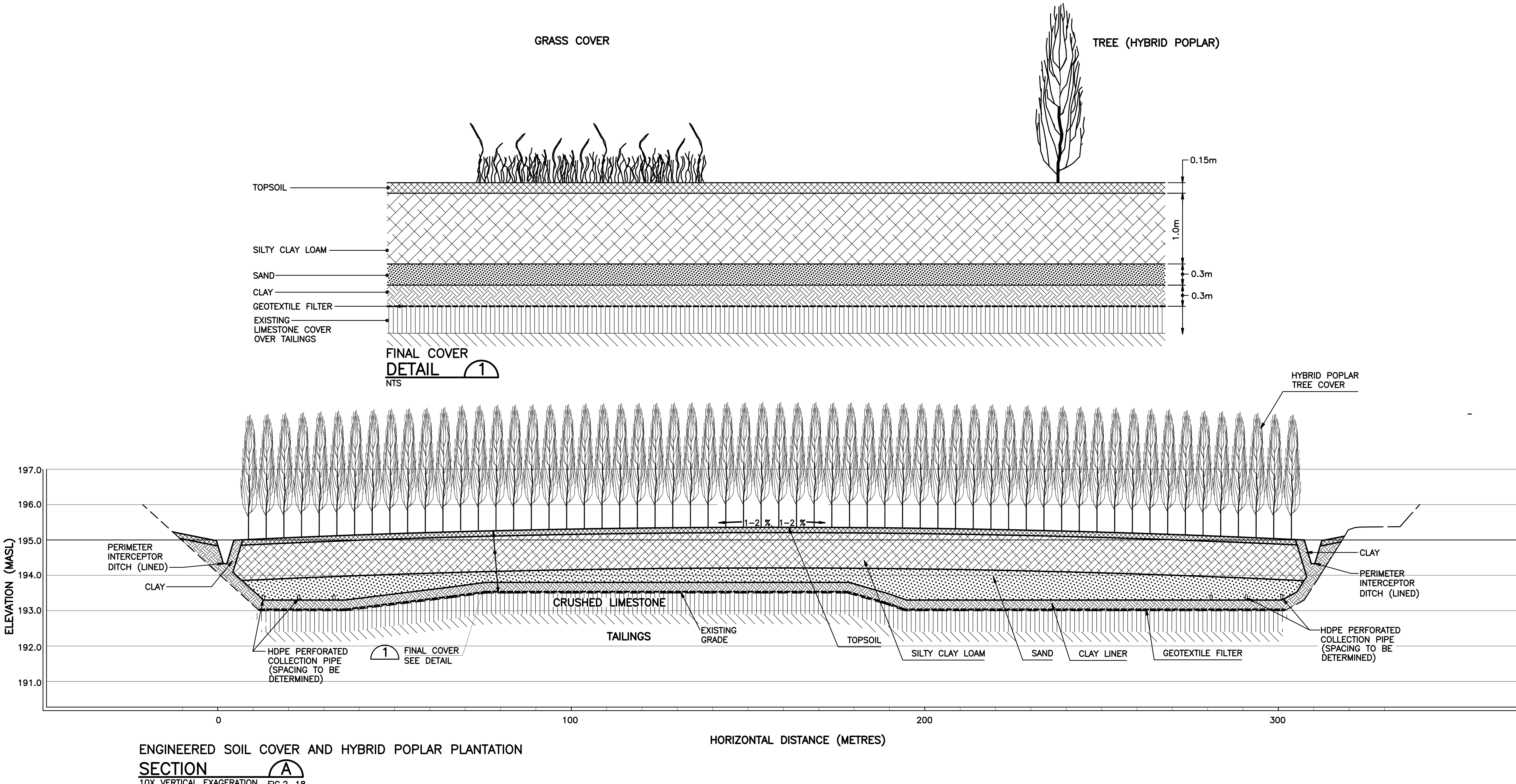

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INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-21
CONCEPTUAL CROSS-SECTION OF THE PROPOSED VEGETATED SOIL COVER

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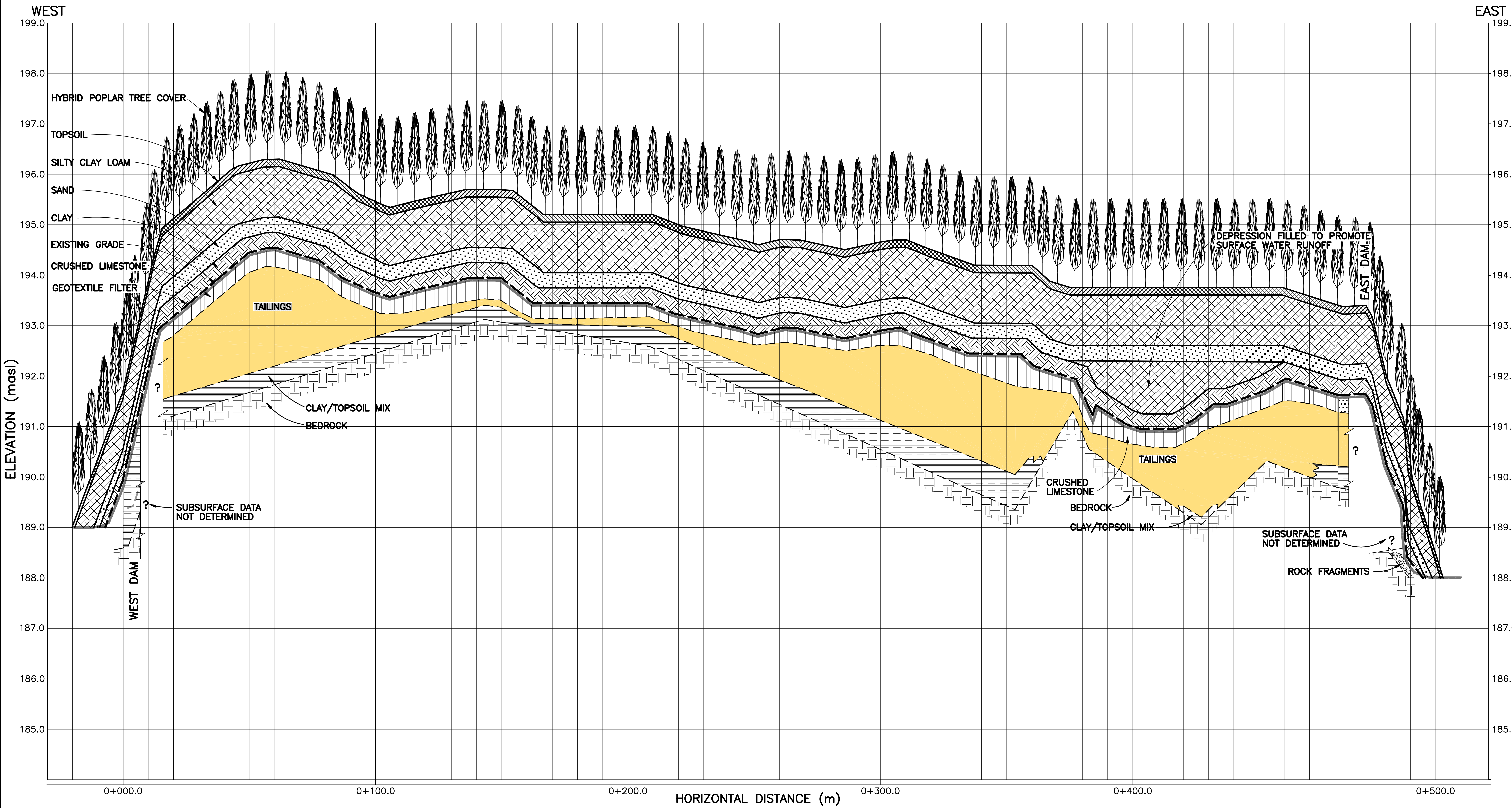
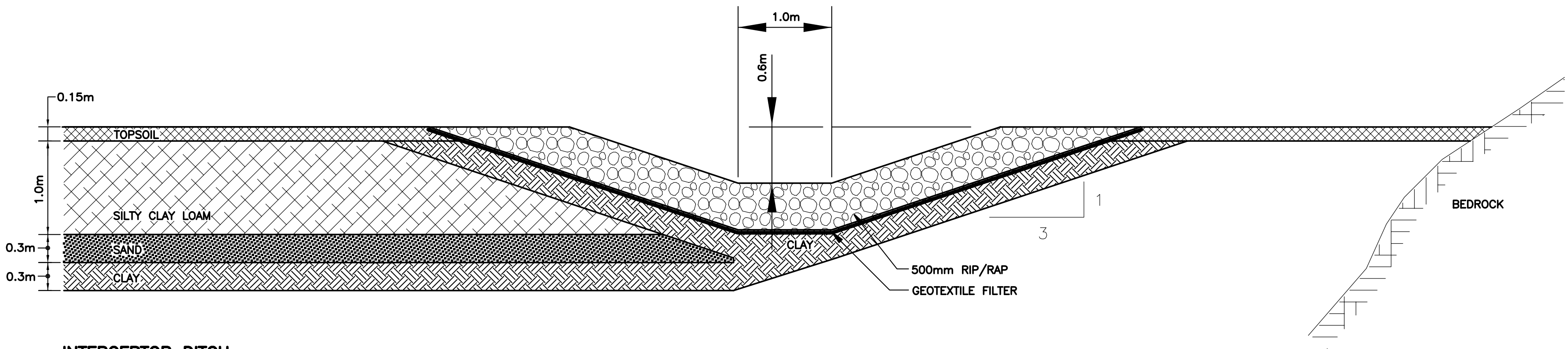


SECTION B
FIG. 2–18

CH2MHILL	INTEGRATED CLEANUP PLAN TAILINGS AREA
PROJECT No. 119548	FIGURE 2-22 CONCEPTUAL CROSS-SECTION OF THE PROPOSED VEGETATED SOIL COVER



INTERCEPTOR DITCH
SECTION E
NTS FIG. 2–18

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PROJECT No. 119548

INTEGRATED CLEANUP PLAN
TAILINGS AREA

FIGURE 2-23
INTERCEPTOR DITCH CROSS-SECTION

During the construction of the engineered soil cover, any existing depressions will be filled in to promote runoff. Final surface grading of the Tailings Area will be designed to promote surface water runoff.

Following the completion of the site rehabilitation measures (i.e. cover/cap placement, stormwater interceptor ditch construction, site grading), the Tailings Area will be landscaped to suit the intended final use and seeded with a mixture of grasses in order to stabilize the surface and limit erosion until the hybrid poplar tree plantation is firmly established.

There is concern that beavers will graze the poplar plantation. One or more of the following solutions can be implemented to create a beaver management plan:

1. Planting of a sacrificial border of poplar trees at the toe of the dam slopes (east and west sides) that would be more readily accessible to the beavers than the poplar plantation. These trees would be felled by the beavers only to re-grow from coppice material that would emerge from the tree stump, growing fresh trees. This is likely the most sustainable option if live-trapping and relocation of beavers or trapping beavers for pelts is considered unacceptable. If the creation of dams and potential subsequent flooding is a concern, trapping will be the only option. Whether the poplar plantation is added to the overall management plan for the site or not, and even if the beaver are excluded from the plantation areas, beavers will continue to create dams and will need to be managed in any case.

2. Beaver live-trapping and relocating would provide the most effective solution assuming a small beaver population. Regular monitoring of the plantation and adjoining wooded areas would be required to determine the extent to which beaver are harvesting trees. Note that trapping of beaver for pelts may be acceptable and letting a contract for a local trapper to harvest the beaver for pelts may be the most cost effective approach.

3. Fencing of the plantation area would exclude beaver, but would also exclude other wildlife. Fence repair and fence integrity monitoring would be required.

4. Spraying the trunks of the trees of the first 10 to 20 rows of trees with a foul tasting rodent deterrent may also be effective and relatively low cost, but would need to be applied on a regular basis.

Note that the above solutions are applicable to all locations where a poplar plantation cover is being considered (Tailings and Industrial Areas).

TA-WP#4: Drill Seepage/Groundwater Collection Wells, and Install Power Supply, Pumps, Heated Enclosures, and Overland Piping to the Industrial Area

Based on loading calculations of arsenic, cobalt, and copper to the Moira River and Young's Creek, it was determined that seepage from both the east and west sides of the Tailings Area contributes significant amounts of cobalt and copper to the Moira River and Young's Creek system on a site-wide basis (CH2M HILL, March 2002a).

A downgradient collection and pumping well system will be installed to capture contaminated seepage beneath the east and west tailings dams and associated contaminated groundwater. The key features of the seepage/groundwater collection system are shown in Figures 2-19 and 2-20. The contaminated water will be pumped from wells to temporary storage tanks located in heated enclosures (1,000 L and 500 L polyethylene tanks in the west

and east dam pumping stations, respectively; see Figures 2-19 and 2-20). In turn, the contaminated water will be pumped from the temporary storage tanks into overland piping and conveyed to the equalization pond (i.e. equalization storage basin) for treatment at the existing ATP. The main contaminant of concern is cobalt, although the seepage contains lesser concentrations of copper and arsenic. Since the existing ATP can satisfactorily remove dissolved cobalt from the onsite contaminated groundwater, based on ATP monitoring data results, the increase in capital, operation, and maintenance costs associated with the installation of a collection and pumping system is considered low compared to the load reduction potential of cobalt to the environment.

All seepage and groundwater conveyance to the equalization pond will be surface mounted, heat traced, and metal clad to reduce the potential for erosion in the unlikely event of a pipe leak. Aboveground piping will also provide for a good visual check for leakage.

The aboveground pipe will cross the Moira River at the existing mine site bridge, as shown in Figure 2-18. The pipe will be secured to the bridge on the upper bridge superstructure so that it can easily be visually inspected for leaks and to provide ease of access in case of need for repair. The pressurized pipe will be housed in a larger diameter pipe across the span of the river with a leak detection sensor that will automatically shut down the pumps in the groundwater collection wells and activate an alarm that will alert operations staff to the leak. The pipe housing the pressurized pipe will extend well onto each riverbank and a small containment area or other containment structure will be built below the pipe ends to capture any leakage that may occur so that it is not discharged directly into the Moira River. Leak detection sensors will be installed along the pipeline and have these same features. In case of a major pipe failure, as noted in Table 7.1 in *the Tailings Area Closure Plan*, an automatic shutoff will be triggered if the backpressure is too low. CH2M HILL has recommended that the piping system be routinely monitored visually for leaks.

2.3.5 Implementation Schedule

The implementation schedule for the recommended alternative for the Tailings Area is presented in Figure 2-24.

2.4 Young's Creek Area Closure Plan

2.4.1 Overview of Recommended Alternative

The recommended remediation alternative for the Young's Creek Area, consistent with the closure objectives, is shown schematically in Figure 2-25. The approximate surface water runoff flowpaths plan for the Young's Creek Area under pre-closure and post-closure conditions is shown in Figures 2-25A and 2-25B, respectively.

The recommended alternative consists of excavating contaminated sediment (both onsite and offsite portions) and underlying contaminated soil (onsite portion only) from the Young's Creek Basin. The excavated sediment and soil will be dewatered and stored in a newly constructed onsite secure containment cell located to the south of the Tailings Area. Following excavation of contaminated material from the Basin, two constructed wetland parcels and a perimeter wetland shelf will be created in the Young's Creek Basin.

Figure 2-24
Tailings Area Closure Plan Implementation Schedule

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		Year 1				Year 2			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation								
TA-WP#1	**Site Preparation**								
TA-WP#2	**Rip/Rap and Geotextile Placement**								
TA-WP#3a	**Cap Installation (clay, sand, HDPE perforated collection pipe, fill material, and topsoil) and Grass Planting**								
	Interceptor Ditch Installation								
	Drainage Ditches Installation								
TA-WP#3b	**Irrigation System Installation**								
	Poplar Plantation Installation								
TA-WP#4	**Seepage/Groundwater Collection System and Overland Piping Installation**								

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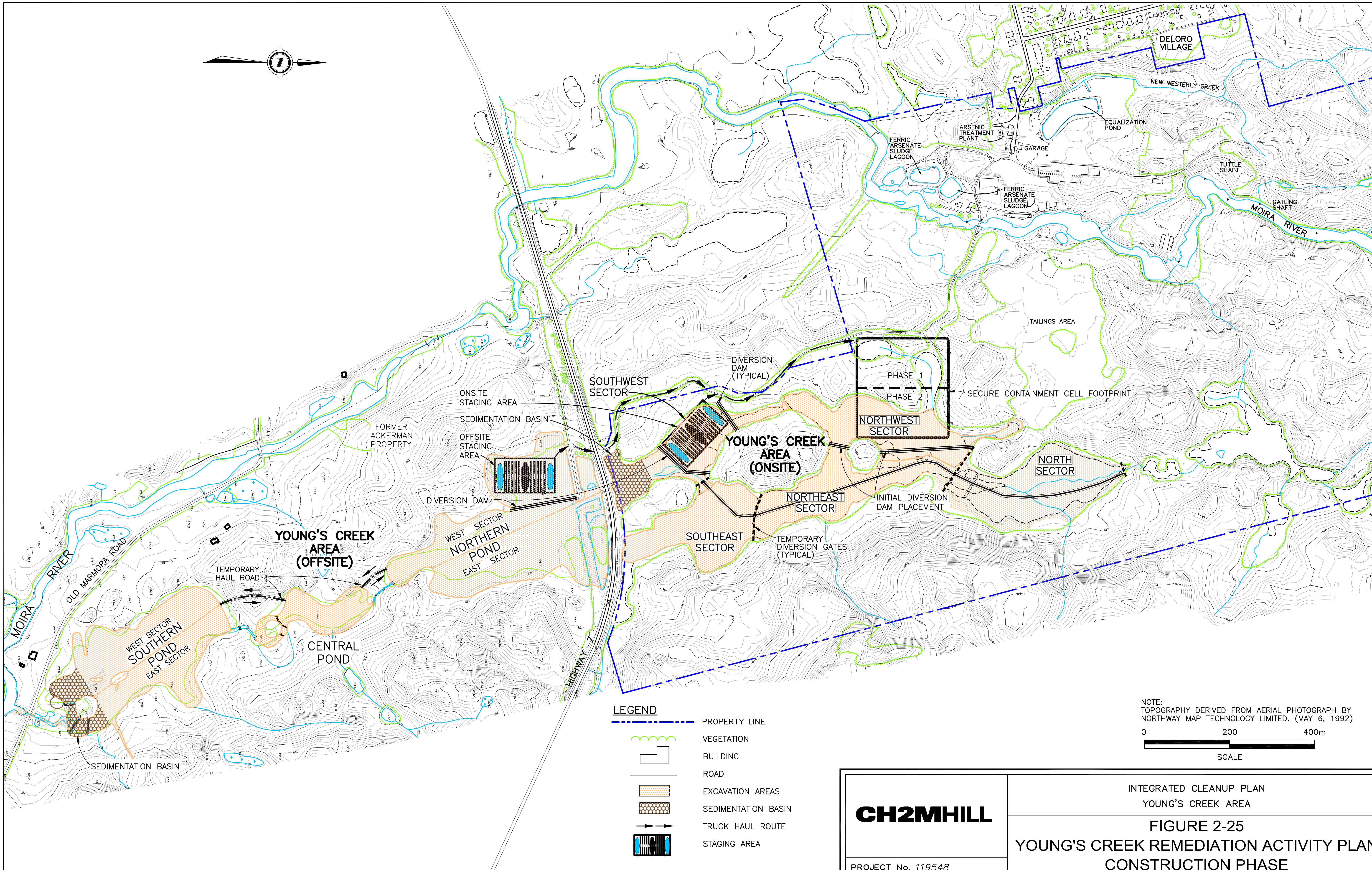

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INTEGRATED CLEANUP PLAN
YOUNG'S CREEK AREA

FIGURE 2-25
YOUNG'S CREEK REMEDIATION ACTIVITY PLAN
CONSTRUCTION PHASE

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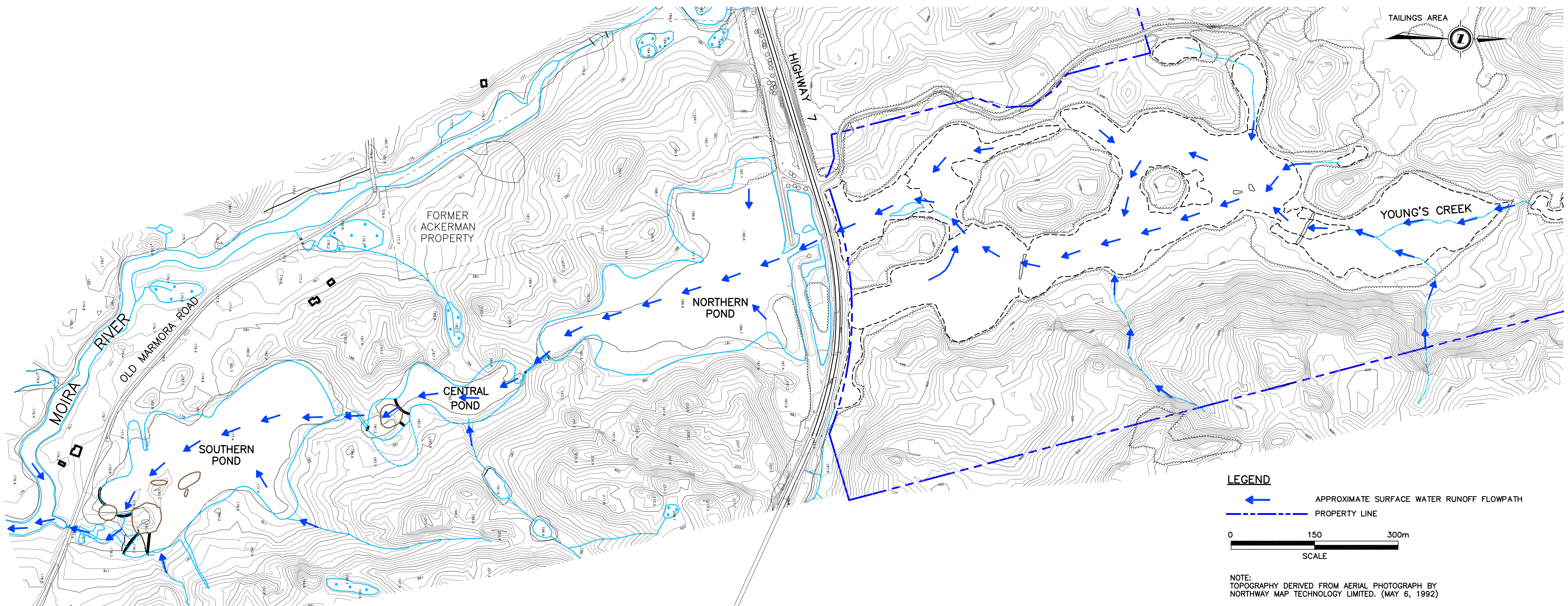

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INTEGRATED CLEANUP PLAN
YOUNG'S CREEK AREA

FIGURE 2-25A YOUNG'S CREEK AREA
APPROXIMATE SURFACE WATER RUNOFF
FLOWPATHS UNDER PRE-CLOSURE CONDITIONS

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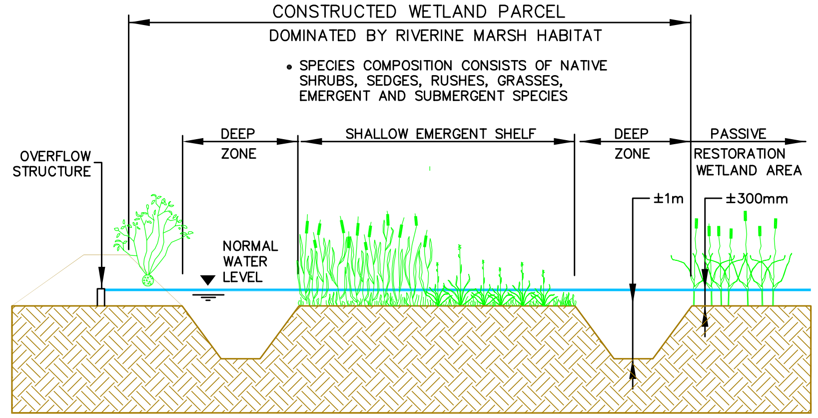

CONSTRUCTED WETLAND PARCEL 1

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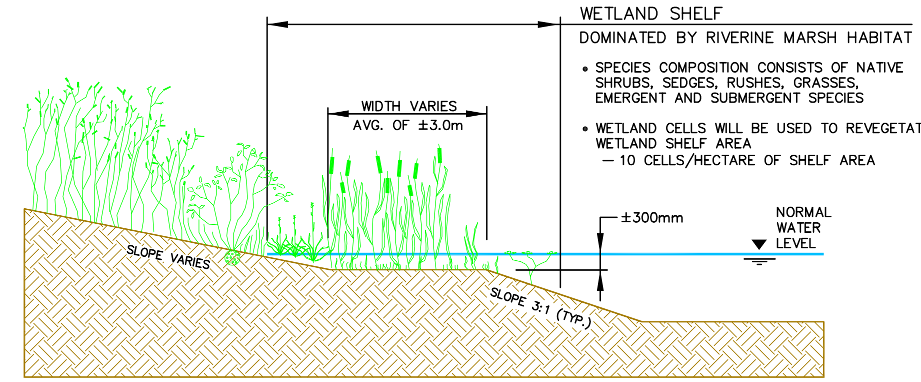

WETLAND SHELF 2

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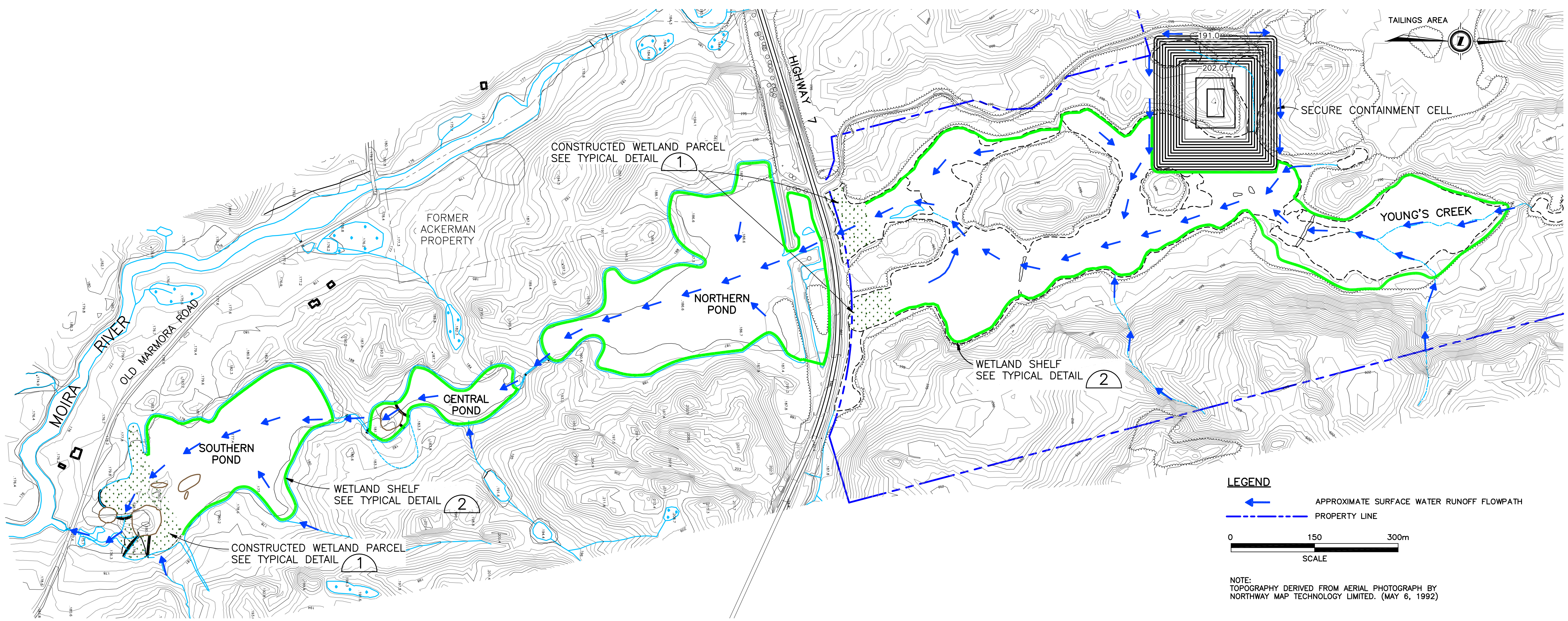

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INTEGRATED CLEANUP PLAN
YOUNG'S CREEK AREA

FIGURE 2-25B YOUNG'S CREEK AREA
APPROXIMATE SURFACE WATER RUNOFF
FLOWPATHS UNDER POST-CLOSURE CONDITIONS

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2.4.2 Cleanup Approach and Extent

The basis of the planned extent of cleanup in the onsite and offsite portions of Young's Creek is summarized below and is described in more detail in the report entitled *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (CH2M HILL, May 2003a).

Onsite Young's Creek Basin. Approximately 199,000 m^3 of contaminated materials will be excavated to an average depth of between approximately 1.0 m and 1.5 m. These contaminated materials, consisting of sediment and lesser impacted underlying silty-clay soil, exceed the MOE's Severe Effect Level (SEL) or Lowest Effect Level (LEL) sediment quality criteria for arsenic and selected metals.

Offsite Young's Creek Basin. Approximately 68,000 m^3 of contaminated sediments will be excavated to an average depth of approximately 0.5 m. These contaminated sediments exceed the MOE's SEL or LEL sediment quality criteria for arsenic and selected metals, although the contaminant concentrations are typically significantly less than present in the onsite sediments.

Approximately 70,000 m^3 of underlying silty-clay soil within the offsite Young's Creek basin, while exceeding MOE's SEL, are not planned to be excavated since the concentrations of arsenic and selected metals are similar to the concentrations found in sediments in the Moira River, Moira Lake, and Stoco Lake. The latter sediments were found have acceptable human health and ecological risks in the report entitled, *Phase II Moira River Study, Impacts of the Former Deloro Mine Site on the Moira River System* (Golder Associates and Global Tox International, January 2001).

Volume Estimates. The detailed estimate of contaminated sediment/soil volumes is provided in the report entitled, *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003a). The estimated quantity of contaminated sediment/soil provided in the latter report is 160,000 m^3 of contaminated organic sediment and 99,000 m^3 of underlying contaminated silty-clay soil. Work completed as part of the SSRA revealed that an estimated 8,000 m^3 of additional contaminated sediment exist in the Young's Creek Basin. The revised volumes of contaminated sediment/soil in the onsite and offsite portion of Young's Creek are summarized in Table 2.9. In summary, there is an estimated 168,000 m^3 of contaminated organic sediment and 99,000 m^3 of underlying contaminated silty-clay soil that will require excavation, onsite transportation, and storage in the secure onsite containment cell.

TABLE 2.9
CONTAMINATED SEDIMENT/SOIL IN THE YOUNG'S CREEK AREA

Location	Average Thickness (m)	Volume (m^3)	As Concentration (µg/g) High/Average	Sediment/Soil Type
Onsite	0 to 0.5 m	100,000	110,000/16,503	**Sediment**: Red silt/organic sediment
Onsite	0.5 to 1.2 m	99,000	7,500/1,800	**Soil**: Inorganic silty clay
Offsite	0.3 m	68,000	1,460/325	**Sediment**: Black organic peat/silt

Note: The estimated volumes of materials to be excavated are subject to the results of the supplementary risk assessment (see below).

The recommended alternative for the Young's Creek Area currently consists of deep excavation onsite (sediment and some soil) and shallow excavation offsite (sediments only). This concept was introduced and discussed in Section 5.4.5 in the *Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003a) and has been retained in the *Young's' Creek Area Closure Plan* and the *Integrated Cleanup Plan.* Many key factors were considered in making this selection, including:

- Under this alternative, the quality of soil remaining in the Young's Creek Area following implementation of this alternative would be similar to the sediment quality downstream from the Deloro site in the Moira River, and Moira and Stoco Lakes. The *Phase II Moira River Study* (Golder, 2001) concluded that there were no obvious adverse effects observed in benthic invertebrates or fish populations due to sediment quality that did not meet the MOE SEL. In this study report, it is noted that arsenic concentrations above the MOE SEL were measured in the Moira River, Moira Lake, and Stoco Lake. Remediating the Young's Creek Area to the similar sediment quality as these downstream water bodies, as opposed to the SEL, is considered a pragmatic approach. This approach could be further optimized should the cobalt criteria developed in the Moira River Study be confirmed as a suitable cleanup criterion.

However, it is recognized that, the findings of the comprehensive *Moira River Study* may not adequately represent conditions in onsite and offsite Young's Creek. Further scientific work is required to define the rationale for the extent of necessary cleanup, including whether the offsite sediments need to be remediated or not. The degree to which contaminated sediments are removed from the Young's Creek Area will be dictated by the results of the SSRA (both human health and ecological). Based on the high levels of contamination present, it is expected that some form of cleanup will be required. In the absence of completed SSRA results, the sediment quality in the Moira River and Moira and Stoco Lakes have been used as a "useful" starting point to estimate the approximate quantity of contaminated sediment that may require cleanup in the Young's Creek Area.

Therefore, the criteria to be used to guide the confirmatory sampling during completion of the future remedial activities will be the MOE SEL criteria or applicable criteria to be developed as part of the supplementary SSRA for the site (see below). It is anticipated that following remediation, the sediment/soil quality will be similar to the ambient sediment quality in the Moira River, Moira Lake, and Stoco Lake.

Supplementary Risk Assessment. Post-closure conditions in Young's Creek (both onsite and offsite) were determined based on the recommended alternative that proposes excavating sediments (and onsite underlying soil) down to a depth where the concentration of metals is generally representative of background conditions. Human health risk assessment results, as presented in the draft SSRA reports, showed that higher concentrations of metals in Young's Creek sediment could be left in place and not result in unacceptable human health risk to onsite and offsite receptors. Ecological risk results for the same post-closure scenarios showed unacceptable risk results for several metals and several receptors. However, the strength of the conclusions associated with these risk results was low, as site-specific data was not available for comparison. Conducting toxicity testing and Tessier extraction analyses, which are used to estimate bioavailability, on sediment samples collected from Young's Creek would provide a greater weight of evidence. As was the case in the Moira River Study, the results of this sampling may show that the effect due to the presence of elevated concentrations of metals may not in fact cause adverse risk to onsite and offsite ecological receptors.

2.4.3 Provincially Significant Wetland and Environmental Benefits in the Cleanup of Young's Creek

One of the key considerations in the development of the remedial measures for the Deloro Mine Site Cleanup Project has been the natural environment and heritage features that are located at and around the mine site area. One important environmental feature existing in this area is a Provincially Significant Wetland (PSW), the Deloro Wetland Complex. Within the Deloro Mine Site boundary, the wetland is situated along Young's Creek north of Highway 7. The wetland however, also extends east of the mine site boundary as well as south of Highway 7 along Young's Creek to the Moira River confluence. The Deloro Wetland Complex was evaluated during the summer of 2000 and received a total score of 688 out of 1,000 and, as a result, was determined to be a Class 2 PSW (Snider, 2000). The wetland was 119 ha in size, contained 22 separate wetland units and extended over almost the entire 6 km^2 of the Young's Creek watershed. The wetland was dominated by riverine marsh habitat including sedges (*Carex sp*.) and bulrushes (*Scirpus sp*.), with lesser quantities of soft rush (*Juncus effusus*), cattail (*Typha sp*.), moss, purple loosestrife (Lythrum salicaria), water milfoil (*Myriophyllum sp*.), manna grass (*Glyceria canadensis*), red-top grass (*Agrostis gigantea*), and dead hardwood trees. A total of three reptile, nine amphibian, 13 mammal, 36 bird, and 121 plant species have been observed in the wetland (CG&S, 1998; Snider, 2000). No provincially significant species were observed; however, four regionally rare species were documented in these surveys including the common raven (*Corvus corax*), rough cotton grass (*Eriphorum tenellum*), water-marigold (*Megalodonta beckii*) and small bladderwort (*Utricularia minor*).

Part of the remedial measures that are proposed for the cleanup project involves removing contaminated sediment from Young's Creek. This removal of sediment will have short and long-term implications on the Deloro Wetland Complex. The Young's Creek contaminated sediments do not appear to pose a significant environmental threat, as they only result in about 2 to 3 percent of the contaminant loading to the Moira River. However, there are a number of known or potential environmental concerns that pose unacceptable human health and ecological risks that support the need for the Young's Creek cleanup:

- The onsite contaminated sediments pose a serious potential hazard if re-suspended during a severe (i.e. 100-year) flood event. Significant quantities of contaminated sediment are located behind the beaver dams in Young's Creek and these dams can fail during major storm events. Re-suspension of these sediments will result in the siltation of the Moira River which will have adverse effects on the fish community. This is especially important as the channel darter, a provincially threatened fish species, has been identified in the Moira River just downstream of the Young's Creek confluence.
- Some of the sediments in the onsite portion of Young's Creek contain radiological contamination.
- The concentrations of arsenic and metals (particularly in the onsite sediments) are many times greater than both the MOE's Sediment Quality Guidelines and those levels measured in the Moira River as part of the *Moira River Study.*
- A waste stream leading from the Tailings Area to Young's Creek contains vegetation that is significantly different than the surrounding area. It is dominated by one species of grass and this lack of biodiversity is a reflection of the high levels of contamination and indicates adverse environmental conditions.

- Sediment collected from the southern end of Young's Creek south of Highway 7 as part of the *Moira River Study* had the lowest values of abundance and diversity of benthic invertebrates observed in the entire study. Also, 100 percent and 86 percent of the two species benthic invertebrates used in the laboratory sediment toxicity testing did not survive in the Young's Creek (south of Highway 7) sediment sample. It is likely that worse environmental conditions exist upstream (north of Highway 7) where the concentrations of metals is much higher.

The environmental benefits will include a significantly improved end state, by addressing the above issues and concerns, and are expected to far exceed the short-term and reversible impacts on the Young's Creek ecosystem. The removal of contaminated sediments from Young's Creek will be supportive of the ecological significance of the Deloro Wetland Complex and will likely enhance wetland health by increasing benthic invertebrate, fish, wildlife and vegetation community biodiversity.

However, the effectiveness of the cleanup project in restoring wetland habitat and improving the health of the Young's Creek ecosystem will be evaluated as part of a follow-up monitoring program. This biomonitoring program, which is described in detail below, will be implemented as part of the recommendations of the federal environmental assessment that is being conducted for the project.

In terms of cost, the magnitude of the capital cost opinion of $15.9 M in Table 5.5 (2004 $; +/- 25 percent) is reflective of the large volume of contaminated sediments and soil present. This contamination has spread over many years to a distance of about 2.5 km downstream of the source (Tailings Area). However, the longer-term operations, maintenance and monitoring (OMM) cost of approximately $620,000 (NPV; 20 years: 5 percent interest rate) is relatively modest, as compared to the OMM cost for the IA, for example.

As part of the supplementary risk assessment referenced in Sections 2.1.2 and 2.4.2, it is planned to conduct sampling for toxicity testing and Tessier extraction analyses, along with supporting sampling and analysis for metals and physiochemical properties, on sediment collected from Young's Creek at depths above the currently proposed depth of excavation (i.e. an intermediate depth). This depth will be determined using the existing chemical data and field notes relating to the depth of previous sampling events. Sediment sampling is proposed to be conducted at two separate intermediate depths at three locations in onsite Young's Creek and three locations in offsite Young's Creek, as well as at two intermediate depths in a reference location to be used as comparison. Performing this additional iteration on the Young's Creek results and associated sampling at intermediate depths may reduce the overall cleanup costs, should the risk to ecological receptors be acceptable.

Measures taken to prevent re-suspension of sediment are discussed in Section 4.3 of the *Young's Creek Area Closure Plan*. In brief, these measures include the use of diversion dams and ditches that will divert natural surface water flow around areas of active excavation, the use of sedimentation basins adjacent to the Highway 7 bridge culvert and at the southern extent of the Southern Pond, and the use of silt control fencing around staging and dewatering areas. Monitoring of water quality will be performed throughout the remediation effort to assess the effectiveness of these measures. The goal during remediation will be to maintain total suspended solids and dissolved metal concentrations in the surface water flows at concentrations not exceeding those measured in Young's Creek prior to remediation activities.

Biomonitoring will be undertaken at the secure containment cell as well as within and along the new banks of Young's Creek. The biomonitoring program will be initiated during the first growing season following containment cell construction and wetland reconstruction, and annually thereafter for a total of five years. Biomonitoring will then be conducted once every five years over a 20-year period, and then every 10 years over the long-term period.

Visual inspections will be conducted for the remedial work proposed along and within Young's Creek. These inspections will assist in ensuring that creek bank stability is not compromised and that the restoration measures implemented, including the installation of any bioengineering structures such as root wads and fascines, are functioning as designed. Following the removal of contaminated sediment, a vegetation planting program will be implemented to enhance and compensate for the loss of wetland vegetation. A variety of vegetation species will be planted to contribute to wetland plant biodiversity and enhance ecosystem health. A series of wetland planting shelves and cells will be created in Young's Creek to assist this program.

Qualified field personnel will monitor and evaluate the success of herbaceous vegetation (i.e. grasses, wildflowers, etc.) seeding and the planting of woody vegetation on the containment cell cap and along Young's Creek. Monitoring will also be conducted of the seeded and transplanted aquatic vegetation (e.g. cattails, sedges, and emergent/submergent species) within the creek. The inspections will ensure that all areas seeded and planted contain growing grass as well as other herbaceous and woody material. Plant health and condition will be monitored and any planted terrestrial or aquatic vegetation that is determined to be inadequate or dead will be replaced. Native colonizing species of terrestrial and aquatic vegetation that germinate and grow in these areas will also be documented.

The biomonitoring program can also include surveys that will document evidence of terrestrial and riparian wildlife use. This would include direct sightings or signs, such as tracks and scat, in the containment cell and Young's Creek areas. Wildlife observations could be documented by qualified field personnel while undertaking vegetation monitoring and thus, would be completed with the same frequency and over the same time period.

To further support the goals and objectives of the Closure Plan, the biomonitoring program may include the collection of plants (leaves and/or stems) from the remediated area during the growing season. The concentration of arsenic and metals of concern in plant tissues could be chemically determined. Trends could be identified and comparisons to benchmark, toxicological and site data could be made to ensure that the goals of the Closure Plan are being met.

Benthic invertebrate and fish community surveys may also be undertaken to document the re-colonization of the onsite and offsite portions of Young's Creek. These surveys would be completed by a fisheries biologist to determine the relative abundance, presence, distribution and diversity of benthic invertebrates and fish, and the activities taking place (i.e. spawning). Fish could also be collected from the onsite and offsite portions of Young's Creek and the concentration of metals in tissue determined. Trends could be identified and comparisons to toxicological and site data could be conducted to ensure that the Closure Plan objectives are being met. These surveys would be conducted contemporaneously with the other monitoring work.

2.4.4 Summary of Work Packages

The work packages associated with the recommended alternative for the onsite and offsite Young's Creek Area are listed in Table 2.10.

TABLE 2.10
IDENTIFICATION OF YOUNG'S CREEK AREA WORK PACKAGES

Package I.D.	Work Package Description
YC-WP#1	Containment Cell Liner System Construction
YC-WP#2	Excavation of Onsite Contaminated Sediment and Soil, Dewatering, and Placement in Containment Cell (includes progressive capping onsite containment cell)
YC-WP#3	Onsite Creek Rehabilitation
YC-WP#4	Excavation of Offsite Contaminated Sediment, Dewatering, and Placement in Containment Cell (includes progressive capping onsite containment cell)
YC-WP#5	Offsite Creek Rehabilitation

2.4.5 Design Description

Site Preparation

Prior to commencing the remedial work, site preparation work will be completed that includes mobilization of equipment (excavators, trucks, dewatering pumps and equipment, site trailers), construction of access roads where required, and establishment of temporary services. It is proposed to complete the excavation work in the "dry"; therefore, any ponded water will need to be drained prior to excavation. Sediment control measures will need to be implemented to minimize the transport of disturbed sediment from Young's Creek to the Moira River.

YC-WP#1: Containment Cell Liner System Construction

Excavated sediment/soil will be placed in an engineered secure onsite containment cell as shown in Figures 2-26 and 2-27. The proposed containment cell will be situated approximately 200 m south of the existing Tailings Area and approximately 600 m north of Highway 7. The footprint of the cell covers approximately 5 ha and will rise approximately 17 m above the existing Young's Creek bed. The containment cell will provide a capacity of approximately 270,000 m^3. It is recognized that depending on the results of the confirmatory sediment/soil sampling to be conducted during excavation activities, an increase in the actual total volume of material that requires excavation and containment in the secure containment cell may occur. As such, the final design capacity of the containment cell may need to be increased above the current estimate of approximately 270,000 m^3 to provide additional storage capacity.

The containment cell will have engineered cap and liner systems that will be designed to prevent contaminant releases. The cap will consist of a vegetated cover, 150 mm of topsoil, 1,000 mm of compacted fill, underlain by a geotextile, a 300-mm cap drainage layer of crushed granular material, and a GCL within a 500-mm sand cushion and sand grading layer to prevent infiltration of surface water. The cap will be designed to promote runoff and evapotranspiration, thereby reducing the amount of precipitation that could come into contact with the contaminated sediment/soil in the containment cell. The cap includes a drainage system to intercept any percolating water that does not run off or is not evapotranspired before it contacts the stored sediment/soil. This clean infiltrating water collected in the cap system will be directed to Young's Creek. The thickness of the cap will also provide the necessary shielding to reduce low-level radiation fields associated with some of the radioactive sediments to be indistinguishable from background.

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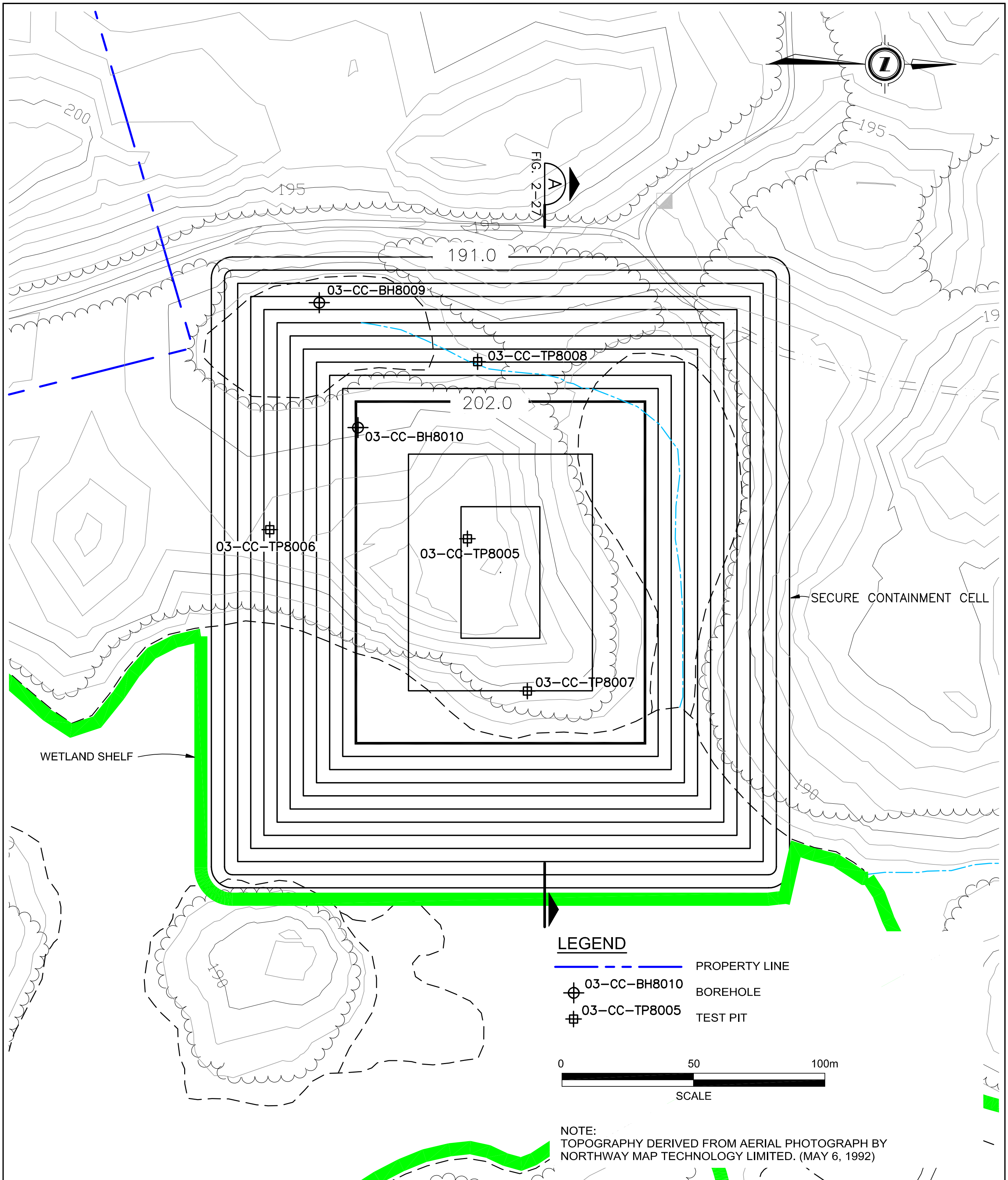

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INTEGRATED CLEANUP PLAN

YOUNG'S CREEK AREA

FIGURE 2-26

CONCEPTUAL DESIGN YOUNG'S CREEK AREA
SECURE CONTAINMENT CELL PLAN VIEW

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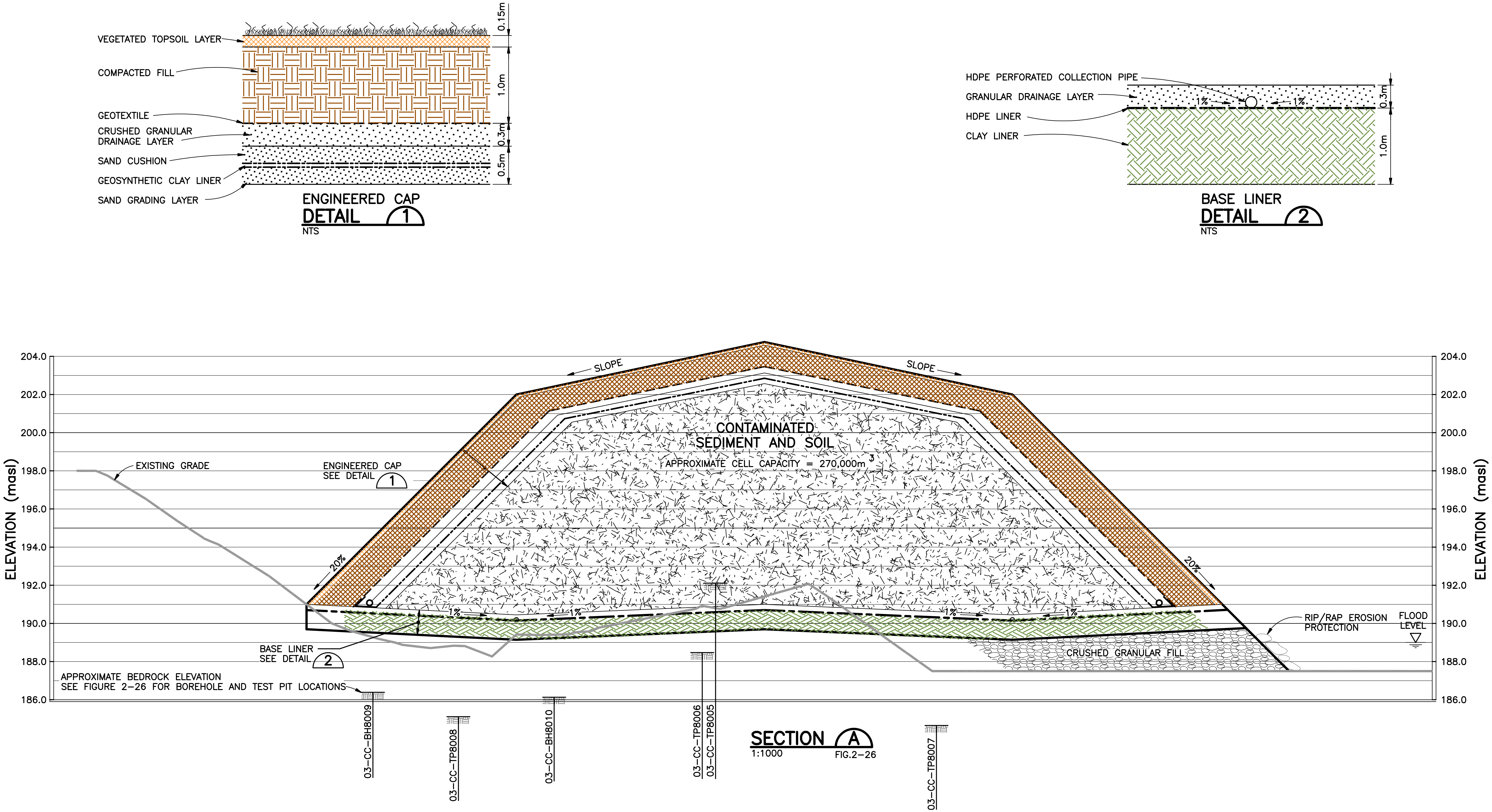

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INTEGRATED CLEANUP PLAN
YOUNG'S CREEK AREA

FIGURE 2-27
CONCEPTUAL DESIGN YOUNG'S CREEK AREA
SECURE CONTAINMENT CELL PROFILE

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The base liner system will consist of 1,000-mm thick composite clay and HDPE liner with a leachate collection system embedded in a 300-mm granular drainage layer to collect any water that does happen to penetrate the cap system. The liquid collected by the leachate collection system will be collected in sumps and stored in a holding tank that will be pumped out as required and transported to the ATP in the Industrial Area. The containment cell will be located above the water table to prevent groundwater contact with stored sediment/soil.

YC-WP#2 and #4: Excavation of Onsite Contaminated Sediment and Soil, and Offsite Contaminated Sediment, Dewatering, and Placement in Containment Cell (includes progressive capping onsite containment cell)

Prior to the excavation of contaminated sediment/soil, temporary staging areas will be constructed. Two separate staging areas will be required, one for the onsite portion and one for the offsite portion of Young's Creek. The proposed locations of the onsite and offsite staging areas are shown in Figure 2-25. The staging areas will provide a stable work platform where wet contaminated sediment/soil can be dewatered and conditioned prior to placement in the secure containment cell. Clay diversion dams will be built as shown in Figure 2-25 to isolate the staging areas from potential flood waters.

Prior to placement in the onsite containment cell, contaminated sediment and soil will require dewatering. Dewatering will occur in the onsite and offsite staging areas shown in Figure 2-25. Excavated contaminated sediment and soil will be dewatered by placing the wet material in windrows, which will be approximately 1.5 m in height and 4 m in width. Windrows will be placed parallel, as shown in Figure 2-28, and be spaced approximately 4 m apart to allow an excavator to travel between the windrows. The excavator will move between the windrows and turn over the wet sediment/soil to promote dewatering and drying. Windrows will, in sequence, be moved closer to the stockpile location.

After approximately five turnover/movements, the sediment and soil should be dry enough to place into the dewatered material stockpile. Bulldozers will be used to create a ramped stockpile that will be approximately 5 m in height. The material stockpiles will eventually be loaded onto trucks for storage in the secure onsite containment cell.

The onsite and offsite staging areas will have an approximate area of 12,000 m^2. The onsite and offsite staging areas will allow sediment/soil to be dewatered at a rate of approximately 1,000 m^3/day. These dewatering rates result in approximately 200 excavation days and 70 excavation days, respectively, being required for the onsite and offsite portions of Young's Creek. The staging areas will be constructed of 150 mm of compacted granular A over a non-woven geotextile underlain by 300 mm of crushed rock over another non-woven geotextile. Silt control fencing will be placed along the perimeter of each staging area to prevent the movement of sediment/soil from the staging area back to the Young's Creek Basin. Sedimentation basins, as described below, that will be located at the downstream end of the onsite and offsite portions of the Young's Creek Basin will provide a back-up measure to the silt control fencing.

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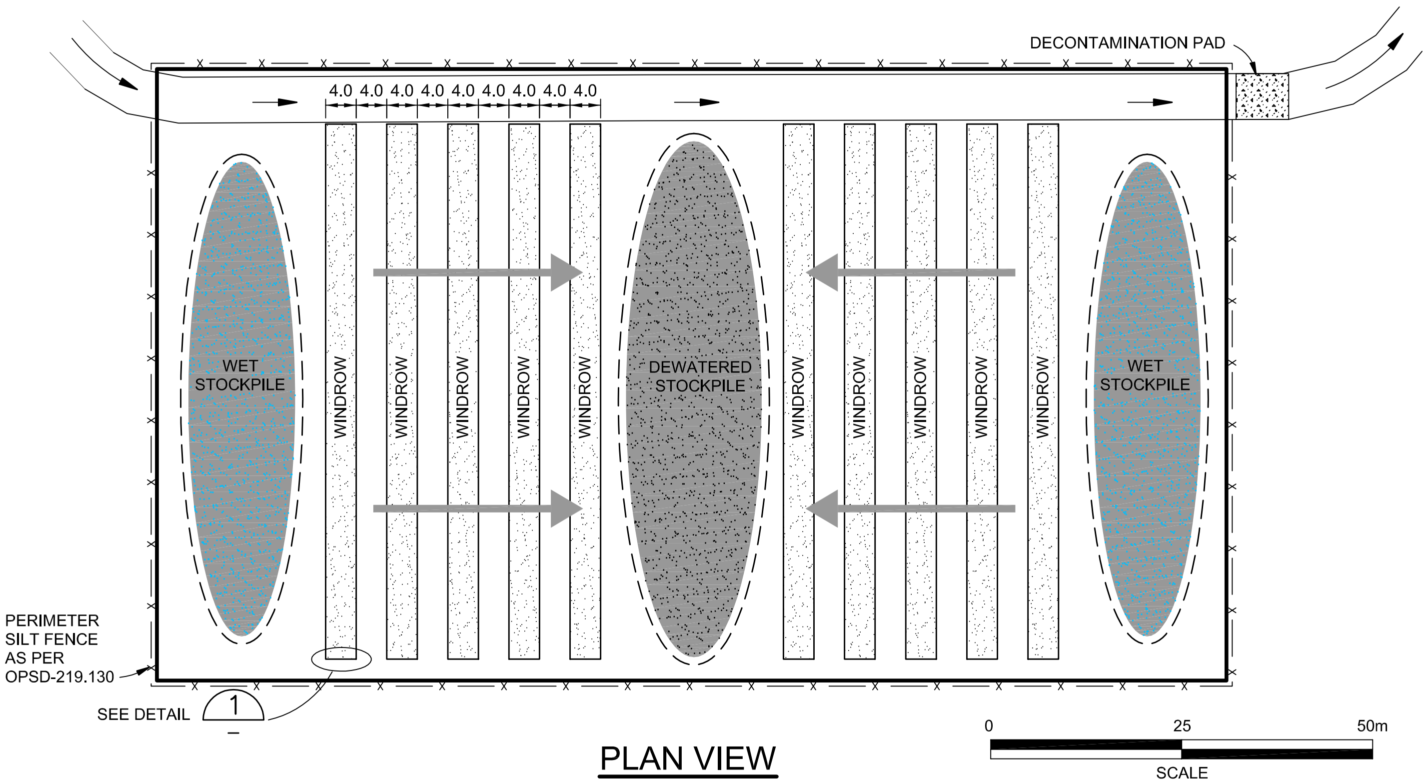
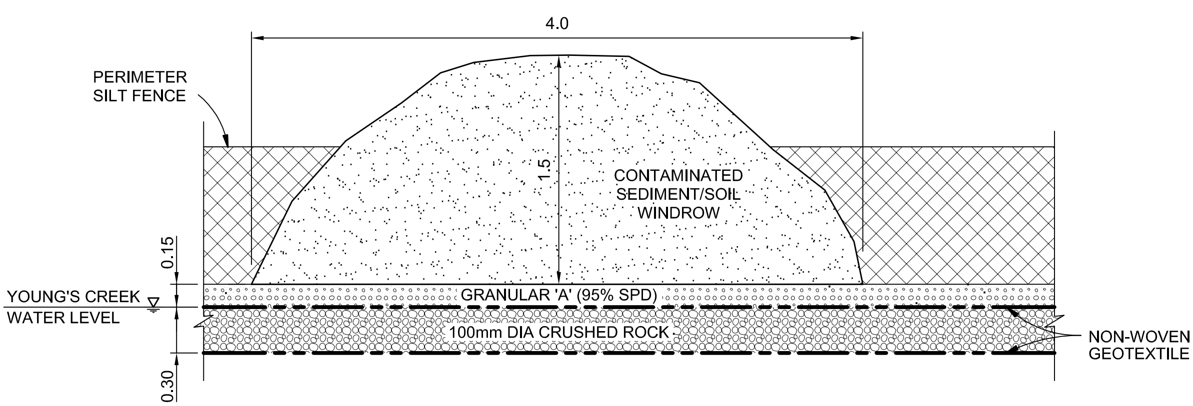


PLAN VIEW



DETAIL 1
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CH2MHILL	INTEGRATED CLEANUP PLAN YOUNG'S CREEK AREA
	FIGURE 2-28 YOUNG'S CREEK AREA STAGING PAD DETAIL
PROJECT No. 119548	

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Two sedimentation basins will be created in the onsite and offsite portions of Young's Creek as shown in Figure 2-25. The sedimentation basins will be sized to allow any suspended sediment resulting from upstream excavation activities to settle out prior to discharge. The sedimentation basin for the onsite portion of Young's Creek will be created in the floodplain north of Highway 7 and will capture suspended sediment before being discharged to the culvert under Highway 7. For the offsite portion of Young's Creek, a sedimentation basin will be created in the southern portion of the Southern Pond to capture suspended sediment prior to discharge to the Moira River. Suspended sediment that accumulates in the sedimentation basins will be removed and placed in the secure onsite containment cell. For the relatively small portion of the creek between Old Marmora Road and the Moira River, sedimentation controls such as geotextile silt fencing, sand bags, and/or straw bales will be used. This portion of the creek will be excavated during a low-flow period to minimize suspended sediment transport to the Moira River.

Once the staging areas and sedimentation basins are in place, temporary diversion dams and ditches will be used to isolate specified sectors of the Young's Creek Basin. The temporary diversion dams will allow flow through the Young's Creek Basin at all times during the work. In general, excavation activities will proceed in the downstream direction to prevent recontamination of remediated areas. The diversion dams will divert surface water flows around the active excavation area and will allow excavation work to proceed in the "dry". An initial potential diversion dam positioning is shown in Figure 2-25. The Northwest Sector should be excavated first to remove contaminated soil and sediment from the footprint of the containment cell. The initial placement of a diversion dam, as shown in Figure 2-25 will allow the Northwest Sector to be excavated in the "dry". Next, a diversion dam will be placed in a north-south orientation to divide the North Sector into an east and west half. Then the west half of the North Sector will be excavated while water is diverted through the east half. Once the west half of the North Sector is remediated, water will be diverted through the west half while the east half is remediated. Once the North Sector is remediated, the diversion dam will be moved downstream to the Northeast Sector and will divide the Northeast Sector into an eastern and western half. As in the North Sector, water will be diverted into one half while the other half is remediated. The Southeast Sector will be remediated in a similar fashion. The area comprising the sedimentation basin will be the last area to be remediated.

The diversion dams will have a base width of approximately 8 m, a top width of 1 m, and a height of 2 m above the existing creek bed. The elevation of the top of the diversion dam will be approximately 0.5 m higher than the flood water level to allow adequate freeboard. The dams will be constructed with a clay core and covered with a layer of rip/rap to prevent erosion. Alternatively, portable sand-filled plastic bladders (called meter bags) may be used in the place of clay diversion dams to divert surface water. These portable units have a height of 1 m and can be stacked as needed to provide the necessary 0.5 m freeboard.

After the diversion dams are in place, any water existing in the sector under consideration will be pumped out into the adjacent portions of the creek on the other side of the diversion dams. After the water has been removed, contaminated sediment will be excavated using track-mounted excavators, loaded, and transported to the staging areas using six-wheel drive articulating dump trucks. The use of these six-wheel drive vehicles will allow transport of contaminated sediment/soil from the excavation site directly to the staging areas without having to leave the Young's Creek Basin. Crushed granular rock will be placed as required, within portions of the dewatered ponds of the Young's Creek Basin, to

create a temporary haul road from each excavation site to the staging area. This crushed granular rock will be removed and reused following the completion of a given sector. Stormwater in the area being excavated will be controlled. Wastes will be dewatered and conditioned. Following dewatering and conditioning, the sediment/soil will be loaded and transported to the secure onsite containment cell.

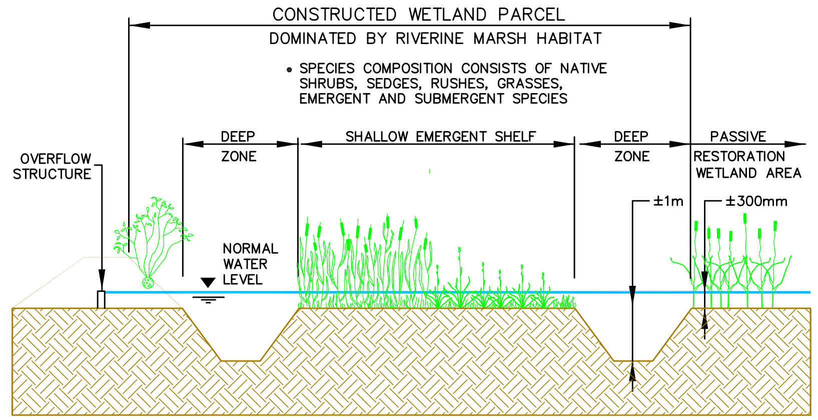
Once excavation activities are completed, the granular A used to construct the staging area will be removed and disposed of in the secure onsite containment cell. The crushed stone underlying the granular A will be removed and stockpiled for future onsite re-use. Contaminated sediment/soil underlying the staging pads will be excavated and transported directly to the secure onsite containment cell. Dewatering of the sediment/soil will occur in the containment cell. The leachate from this dewatering will be collected by the leachate collection system.

Dewatered sediment/soil will be loaded onto trucks and transported to the secure onsite containment cell. For the onsite portion of the excavation work, trucks will use the existing access road that runs parallel to the onsite portion of Young's Creek as shown in Figure 2-25. No offsite transport of contaminated sediment will be required for the onsite portion of Young's Creek. Temporary access roads are not required in the onsite portion of Young's Creek.

For excavation work in the offsite portion of Young's Creek, temporary access roads will be required between the ponds to permit movement of contaminated sediment from the Central and Southern Ponds to the staging area in the Northern Pond. These temporary access roads will be constructed at the proposed locations shown in Figure 2-25. The access roads will be approximately 5 m in width. Material used to construct the temporary access roads include a non-woven geotextile placed on the sub-grade, 300 mm of compacted granular B, followed by 150 mm of compacted granular A. Crushed granular rock will be placed, as required, to create temporary haul roads within portions of the dewatered ponds. Following dewatering and stockpiling in the staging area, the contaminated sediment will be transported to the onsite containment cell along the route shown in Figure 2-25. The transport trucks will be required to cross Highway 7 at the location shown. The trucks will then use the access road that runs parallel and to the west of the onsite portion of Young's Creek to access the onsite containment cell.

YC-WP#3 and #5: Onsite and Offsite Creek Rehabilitation

Following excavation of contaminated sediment and soil, grading will be carried out to provide a wetland shelf around the perimeter of the ponded areas, as shown in Figure 2-29, to re-establish the wetland environment. The shelf will be graded to provide an optimum water depth (approximately 300 mm) to support a diverse wetland community associated with the dominant riverine marsh habitat. The shelf will be continuous around the perimeter and have varying widths of +/- 3 m based on both aesthetic and MNR requirements. A 75-mm to 100-mm depth of topsoil will be required on top of the wetland shelf to provide an ideal environment for seed germination and subsequent root development. The shelf will provide limited treatment potential, but will stabilize the soil and provide an aesthetic function. The perimeter shelf will also create the hydrological conditions that will provide an ideal environment for the natural revegetation to occur.



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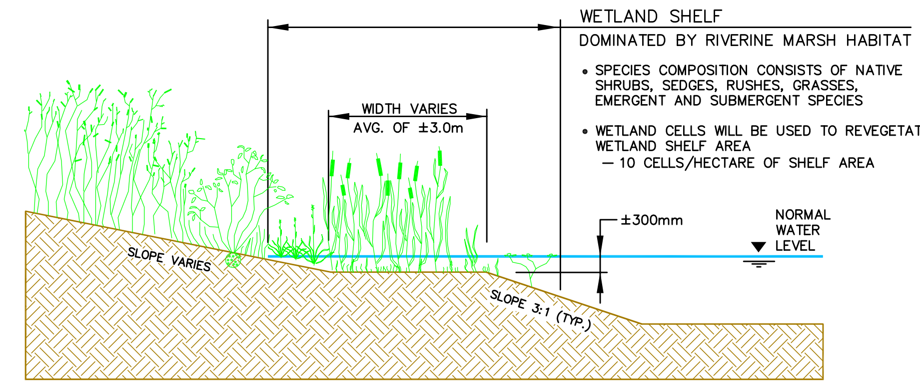

WETLAND SHELF (2)

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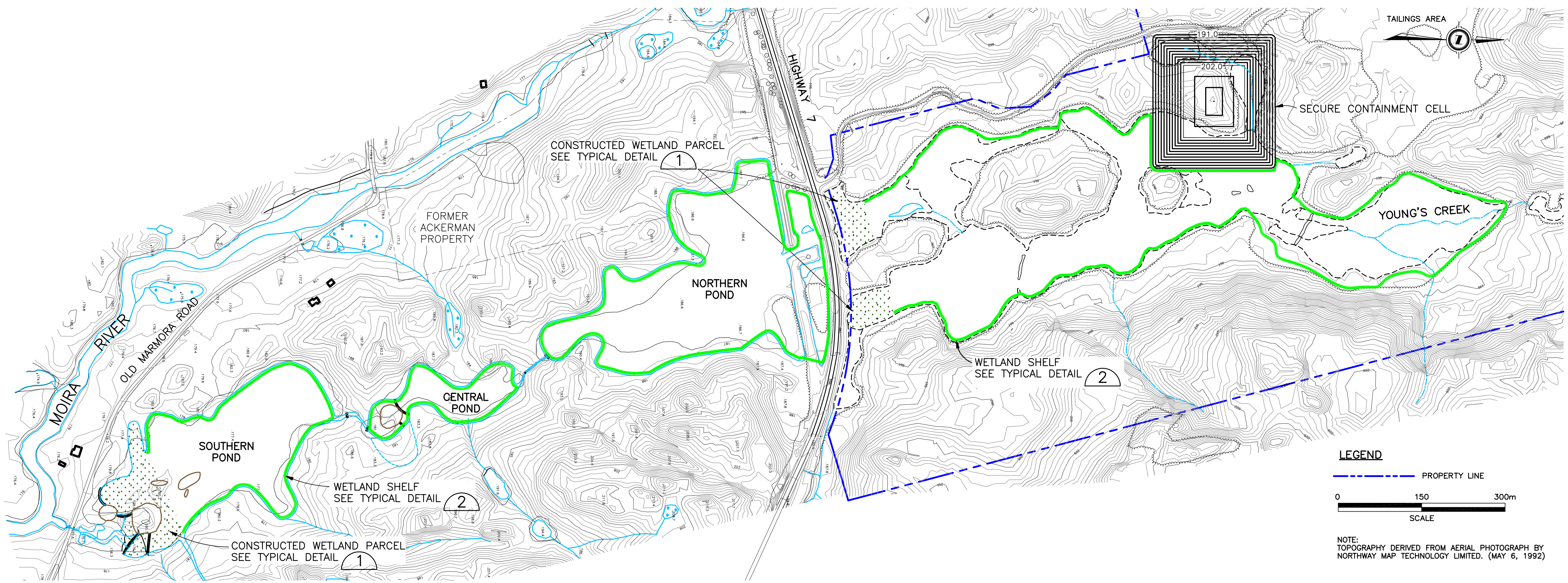

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PROJECT NO 119548

INTEGRATED CLEANUP PLAN
YOUNG'S CREEK AREA

FIGURE 2-29 YOUNG'S CREEK AREA
SITE REHABILITATION AND REVEGETATION
PLAN VIEW AND DETAIL

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A series of wetland planting cells will be initiated at strategic locations throughout the wetland perimeter shelf. The wetland planting cell is an approximately 10-m by 10-m area, within which a specific plant mix is established that consists of seed and potted plant stock. The proposed species composition is native shrubs, sedges, rushes, grasses, and emergent/ submergent species. The wetland planting cells replace the seed bed contained in the upper 500 mm of stripped soil and the substrate seed bed that was covered with 300 mm of imported soil. The proposed density is ten planting cells per hectare of shelf area or three planting cells per kilometre of creek bank.

Two constructed wetland parcels will be located as shown in Figure 2-29 to provide water quality improvements. One wetland parcel will be located onsite at the southern extent of the remediated area just upstream of Highway 7. The offsite parcel will be located just upstream of the point of discharge into the Moira River. The wetland parcels will provide some level of treatment and filtration prior to the discharge of creek water into the Southern Pond and the Moira River.

The construction of the wetland parcels will involve placement of fill material to create the appropriate hydrological conditions to establish a shallow emergent shelf. Planting of native shrubs, sedges, rushes, grasses, and emergent/submergent species by both seed and transplanting will be completed.

2.4.6 Implementation Schedule

A four-year implementation schedule for the recommended alternative for the Young's Creek Area is presented in Figure 2-30.

As noted in Section 2.4.5, the onsite and offsite staging areas will allow sediment /soil to be dewatered at a rate of approximately 1,000 m^3/day. This dewatering rate results in approximately 200 excavation days and 70 excavation days, respectively, being required for the onsite and offsite portions of Young's Creek. However, the four-year schedule allows for up to a maximum of approximately 340 and 200 excavation days for the onsite and offsite areas of Young's Creek, respectively. (Based on an assumption of a maximum of 40 working days available in Spring [April and May] and in Fall [September and October], and a maximum of 60 working days available in summer [June, July, and August].) The additional time available in the four-year schedule, if needed, provides a "buffer" in the event that excavation or excavation and dewatering activities take longer than estimated, due to an actual average dewatering rate of less 1,000 m^3/day, inclement weather, acts of nature, or difficult working conditions in the Young's Creek Basin, particularly in the offsite portion where the water depth of the three ponds is generally deeper than the water depth in the onsite portion of Young's Creek.

2.5 Key Performance Indicators

The ability of the design components of each recommended alternative to achieve or support the closure objectives presented in Section 1 are examined below in terms of key performance indicators. The key performance indicators are drawn from the respective Closure Plans and are expressed in qualitative (e.g. design approach) and quantitative terms (e.g. modelling results).

Figure 2-30
Young's Creek Area Closure Plan Implementation Schedule

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		Year 1				Year 2				Year 3				Year 4			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation																
YC-WP#1	**Containment Cell Liner System Construction**																
	a) Phase 1																
	b) Phase 2																
YC-WP#2	**Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell**																
	a) Staging Area Construction																
	b) Sedimentation Basin																
	c) Temporary Diversion Dams																
	d) Western Portion Excavation																
	e) Eastern Portion Excavation																
	f) Cap Construction																
YC-WP#3	**Onsite Creek Rehabilitation**																
	a) Constructed Wetland Parcel																
	b) Perimeter Wetland Shelf																
	c) Wetland Planting Cells																
YC-WP#4	**Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell**																
	a) Staging Area Construction																
	b) Sedimentation Basin																
	c) Temporary Diversion Dams																
	d) Northern Pond																
	e) Central Pond																
	f) Southern Pond																
	g) Cap Construction																
YC-WP#5	**Offsite Creek Rehabilitation**																
	a) Constructed Wetland Parcel																
	b) Perimeter Wetland Shelf																
	c) Wetland Planting Cells																

All of the low-level radioactive materials will be excavated and/or covered in the Industrial Area and other areas of the site such that the radiation fields will be reduced to less than 0.12 μSv/h, the upper limit of background levels at the site, and to normal background levels of 0.03 to 0.06 μSv/h, if possible.

2.5.1 Industrial Area

Key performance indicators for the Industrial Area include:

- Capping of the entire Industrial Area eliminates contact of surface water runoff with highly leachable and marginally leachable wastes/soils
- The engineered cap/hybrid poplar trees (over consolidated HLW) will allow only approximately 4 percent infiltration of annual precipitation
- The passive GIWN will:
  - Intercept approximately 960 m^3/day of unimpacted groundwater before passing through the site
  - Completely dewater wastes and overburden, together with existing pumping stations (see cross-sections 2-8 and 2-9); this is necessary since current groundwater flow through the HLW in the Industrial Area is responsible for the majority of arsenic loading (approximately 80 percent) to the Moira River
  - Result in relatively low interference with the Deloro Village potable well (less than 2 m)
  - Minimize the potential to intercept contaminated groundwater from beneath the engineered cap to the GIWN which is small versus total flow (flow ratio of 12.9:1)
- Estimated reduction in arsenic loading to the Moira River, as a result of the waste consolidation, capping, and groundwater interception measures:
  - 52.1 kg/day (1979)
  - <10 kg/day (since 1983)
  - Approximately less than 1 kg/day (after cleanup to meet the overall closure objective of a 90 percent reduction in arsenic discharge to the Moira River to achieve current/interim PWQO in the Moira River downstream of the site)
- Implementation of the recommended alternative for the Industrial Area is also expected to provide safe, long-term containment of the Industrial Area wastes, including the low-level radioactive wastes

2.5.2 Mine Area

Key performance indicators for the Mine Area include:

- The HLW will be excavated and transferred for consolidation under the engineered cover, eliminating these sources in the Main Mine Area and the Remote Mine Areas
- The waste rock stockpiles and marginally leachable wastes/soils will be capped, minimizing leachate generation
- Increasing pumping at the Tuttle Shaft to year-round pumping eliminates the artesian discharge of arsenic contaminated groundwater to Moira River

- The cleanup activities and year-round pumping at the Tuttle Shaft (together with the cleanup activities to be undertaken in the Industrial Area) is expected to result in very low arsenic loading to the Moira River (approximately less than 1 kg/day)
- Implementation of the recommended alternative for the Mine Area is also expected to provide safe, long-term containment of the remaining wastes/soils in the Main Mine Area, and includes the removal of a small quantity of low-level radioactive wastes for consolidation with similar wastes in the Industrial Area

2.5.3 Tailings Area

Key performance indicators for the Tailings Area include:

- The engineered cover/hybrid poplar trees will allow less than approximately 10 percent of the annual precipitation to infiltrate to the underlying tailings, thereby minimizing the generation of new contaminated seepage beneath the walls of the tailings dams
- The interceptor ditch will divert upstream, non-impacted surface water from the Tailings Area, further minimizing infiltration of surface water into the tailings
- The above-noted cleanup measures, together with the pumping and treatment of contaminated seepage from beneath the walls of the tailings dams, is expected to eliminate or substantiality minimize the cobalt and copper loading from the Tailings Area to the Moira River
- Implementation of the recommended alternative for the Tailings Area is also expected to provide safe, long-term containment of the tailings, including the radioactive tailings

2.5.4 Young's Creek Area

Key performance indicators for the Young's Creek Area include:

- Removal of the contaminated sediments/soils, including some radioactive sediments that originated from the Tailings Area will address current risks/concerns:
  - Exposure to radiation
  - Elevated human health and ecological risk
  - Potential erosion/transport of contaminated materials downstream during severe storm events/acts of nature
  - Undesirable risk to public and ecological receptors in offsite portion of Young's Creek (offsite portion of Young's Creek is not fenced)
- The secure containment cell is expected to provide safe, long-term storage of these materials, including the radioactive tailings/sediments

3. Integrated Cleanup Schedule

An integrated cleanup schedule has been developed based on:

- The work packages and implementation schedules prepared for the four main areas of the site (Section 2)
- Consideration of a several elements pertaining to the prioritization (Section 3.1) and optimization (Section 3.2) of cleanup activities on a site-wide basis

The factors contributing to the development of an integrated schedule are presented and discussed in this section. As a result of this effort, it was concluded that a hypothetical three-year construction period was the shortest period achievable given the competing factors affecting the implementation plan. The schedule can be readily adapted for implementation over a longer period, should this be desirable. However, it is unlikely that work can be sequenced to allow a shorter duration than three years. As a result, a hypothetical three-year construction schedule has been developed (Figure 3-1) to illustrate how the work could be sequenced and to demonstrate that this construction period is achievable. The actual implementation plan will be developed as the construction period approaches.

3.1 Prioritization of Integrated Cleanup

The key elements that dictate the priority of implementation of the various work packages are examined below. The most important priority involves the need to significantly reduce arsenic loading to the Moira River, consistent with the overall closure objective of achieving a 90 percent reduction in arsenic discharge to the Moira River to achieve the current/interim PWQO in the Moira River downstream of the site. Minimizing the risk of recontamination of the Young's Creek Area and consideration of critical path sequencing of work packages between the main areas of the site are other elements that also influence the prioritization of the integrated cleanup.

3.1.1 Reduction in Contaminant Loading

Loading reduction and risk indexes for arsenic, cobalt, and copper in the Moira River were developed in the report entitled, *Deloro Mine Rehabilitation Project – Development of a Sitewide Water and Load Balance, Final Report* (CH2M HILL, March 2002a). A summary of these results is presented in Table 3.1.

TABLE 3.1
LOADING REDUCTION AND RISK INDEXES FOR THE DELORO SITE AS MEASURED AT HIGHWAY 7 (CH2M HILL, MARCH 2002A)

	Sum of Components (kg/yr)	Allowable Loading (kg/yr)	Loading Reduction (kg/yr)	Risk Index	Priority
Arsenic	5,105	620	4,485	8.2	1
Cobalt	549	112	437	4.9	3
Copper	622	124	498	5.0	2

Figure 3-1
Proposed Project Schedule

Deloro Mine Site Cleanup, Integrated Cleanup Plan

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Ontario

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Work Package ID Number	Description	Estimated Duration (Days)	Year 1				Year 2				Year 3			
			Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
	Year 1													
IA-WP#1	Site Preparation	55		■	■									
IA-WP#6.1	Construction of Clay Berm Around Perimeter of Equalization Pond	20		■										
IA-WP#2.1/2.2	Demolition of Buildings and Tanks and Resizing and Consolidation of Ruins	30			■									
IA-WP#3	Riverbank Reconstruction	41			■	■								
IA-WP#6.2	Placement of 500-mm Clay Cover over Riverbank Wastes (bottom layer of engineered cover)	5				■								
TA-WP#1	Site Preparation	10		■										
TA-WP#2	Placement of Rip/Rap and Geotextile	15		■										
TA-WP#3a	Installation of Engineered Cap, Interceptor Ditch, Drainage Ditches, and Planting of Grass	95		■	■	■								
YC-WP#1a	Construction of Stage 1 Containment Cell Liner System	120		■	■	■								
YC-WP#2a	Excavation of Onsite Contaminated Sediment and Soil, Dewatering and Placement in Containment Cell (includes progressive capping of onsite containment cell)	100			■	■								
	Year 2													
	IA Crew #1													
IA-WP#4	Consolidation of Highly Leachable/Hazardous Wastes	40						■	■					
IA-WP#6.3 & 6.4	Completion of 500-mm Clay Cover over Wastes from Northern and Southern IA (bottom layer of engineered cover)	61							■	■				
	IA Crew #2													
IA-WP#4	Consolidation of Highly Leachable/Hazardous Wastes	87						■	■					
IA-WP#5	Simple Earth (Clay) Cap Placement	21								■				
	IA Crew #3													
IA-WP#5	Simple Earth (Clay) Cap Placement	98						■	■	■				
MMA-WP #1a	Excavation of Highly Leachable Waste, Low-Level Radioactive Slag and Infill/Vegetate, and Reconstruct Riverbank (if required)													
RMA-WP #1b	Excavation of Impacted Soils and Infill/Vegetate	**120**						■	■	■				
MMA-WP #2a	Covering of Waste Rock and Marginally Leachable Soil, and Vegetate								**(for MMA-WP#1a through RMA-WP#2b)**					
RMA-WP #2b	Covering of Waste Rock and Vegetate													

Figure 3-1
Proposed Project Schedule

Deloro Mine Site Cleanup, Integrated Cleanup Plan

Ministry of the Environment
Ontario

CH2MHILL
Responsible Solutions for a Sustainable Future™

Work Package ID Number	Description	Estimated Duration (Days)	Year 1				Year 2				Year 3			
			Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
TA-WP#3b	Installation of Irrigation System and Poplar Tree Plantation	40						■						
YC-WP#1b	Construction of Stage 2 Containment Cell Liner System	120						■	■	■				
YC-WP#2b	Excavation of Remaining Onsite Contaminated Sediment and Soil, Dewatering and Placement in Containment Cell (includes progressive capping of onsite containment cell)	140						■	■	■				
	Year 3													
IA-WP#6.5	Placement of Remaining Layers of Engineered Cover	41										■	■	
IA-WP#7	Installation of Groundwater Interceptor Well Network	100										■	■	■
IA-WP#8	Site Revegetation	30										■		■
MMA-WP #3	Upgrade of Tuttle Shaft Pumping System Installation, and Installation of Overland Piping to Industrial Area	30												■
TA-WP#4	Drilling of Seepage/Groundwater Collection Wells, and Installation of Power Supply, Pumps, Heated Enclosures, and Overland Piping to Industrial Area	40												■
YC-WP#3	Onsite Creek Rehabilitation	80										■		■
YC-WP#4	Excavation of Offsite Contaminated Sediment, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)	140										■	■	■
YC-WP#5	Offsite Creek Rehabilitation	100											■	■

Notes: i) For the purposes of this integrated schedule, the seasons are defined by the following months and the assumed maximum number of working days are shown in brackets:

- Spring: April and May (40)
- Summer: June, July, and August (60)
- Fall: September and October (40)

ii) The actual estimated number of working days for a given work package are shown in the third column, and the season(s) during which the given work package will be implemented are shown in the schedule (actual duration may be less than maximum number of working days available in given season[s]).

iii) The integrated cleanup schedule will be refined during final design and may need to be revised to incorporate restrictions in timing of cleanup activities to comply with upcoming conditions of various permits/approvals.

According to the risk indexes identified in Table 3.1 and the priority with which the contaminants must be addressed, arsenic is of the greatest concern. Furthermore, loading from the west bank of the Moira River (Industrial Area and Main Mine Area) is the main area of the arsenic loading from the Deloro Mine Site, contributing at least 98 percent of the total loading north of Highway 7 (CH2M HILL, March 2002a). Therefore, cleanup of contaminant sources of arsenic in the Industrial Area and the Main Mine Area are prioritized for early cleanup in Figure 3-1, commencing in Year 1 for the Industrial Area and Year 2 for the Mine Area (also see Section 3.1.3).

3.1.2 Minimize Risk of Recontamination of Young's Creek Area

The contaminated sediments in the Young's Creek Area are the result of historical contamination from the Tailings Area. Even though the current risk is low, given that the Tailings Area surface has been covered with crushed limestone and crushed limestone berms have been constructed to buttress the tailings dams walls, the capping of the Tailings Area should be largely completed before cleanup of the Young's Creek Area, to avoid the risk of further contamination of the Young's Creek Area. Figure 3-1 shows that the majority of the cleanup in the Tailings Area related to further securing the tailings will be completed in Year 1 (capping and drainage activities, followed by installation of the hybrid poplar tree plantation in Year 2), while the cleanup of the onsite and offsite portions of the Young's Creek Area is shown to occur over three years.

3.1.3 Critical Path Sequencing of Work Packages between Key Areas

Examples of critical path sequencing of work packages between the key areas of the site include:

- The excavation of HLW/soil from the Mine Area and transfer to the waste consolidation area in the Industrial Area will need to occur within the same time-frame as similar waste consolidation activities in the Industrial Area. Therefore, as shown in Figure 3-1, excavation of the HLW/soil from the Mine Area will take place in Year 2 to coincide with similar activities in the Industrial Area.
- In order to prevent damage to overland piping from the upgraded Tuttle Shaft pumping system (Figure 2-13) and the overland piping from the seepage/groundwater collection wells in the Tailings Area (Figure 2-18), the engineered and simple earth (clay) caps in the Industrial Area will need to be completed prior to the installation of the overland piping from the Mine and Tailings Areas. This aspect of critical path sequencing is addressed in Figure 3-1 in Year 3, whereby the engineered cap is projected to be completed by the end of Summer and the overland piping from the Mine and Tailings Area will be installed during the Fall period.

3.2 Optimization of Integrated Cleanup

The recommended Closure Plan for each main area of the site, as summarized in Section 2, were each based on selection of an alternative that satisfied the greatest number of detailed evaluation criteria. The detailed criteria included evaluation of technical and social considerations, cost, and the natural environment. (The alternatives evaluation is summarized in Section 1 and is described in detail in the four Alternatives Reports.)

Therefore, in order to successfully undertake cleanup of the four main areas of the Deloro Mine Site, the recommended Closure Plans have been "optimized" to be most supportive of technical considerations, costs, social considerations, and the natural environment.

In terms of the site-wide cleanup, an integrated cleanup schedule that is optimized to occur over the shortest possible time is clearly most supportive of addressing the site-wide and specific area objectives described in Section 1 and, overall, will have the ability to more rapidly achieve the project objective:

> *To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.*

The total duration of the integrated cleanup schedule will be dictated by the cleanup in the Industrial Area and Young's Creek Area since the majority of site cleanup is required in these two areas (approximately 75 percent of the total capital cost; see Section 5). As shown in Section 2, the implementation schedules for the Industrial Area Closure Plan and Young's Creek Area Closure Plan are up to five years and four years, respectively. The implementation schedule for both the Tailings Area and the Mine Area are shorter and cover a duration of only two years (and recognizing, as noted in Section 3.1.3, that construction of overland piping from both the Mine Area and the Tailings Area cannot be installed until capping activities are completed in the Industrial Area).

As noted in Section 2.1.5, the implementation schedule for the Industrial Area could be condensed from five years to three years (Figure 2-12b). The condensed program would require several work crews working simultaneously and include:

- Demolition of buildings, consolidation of ruins, and reconstruction of the western riverbank in Year 1
- Consolidation of wastes and cover with a 500-mm clay cover at the end of Year 2; placement of simple earth (clay) caps in the North and South Industrial Area during Year 2; and completion of the engineered cover late in Year 2
- Installation of the GIWN in Year 3, concurrent with revegetation of the Industrial Area with grass, and poplar trees on the engineered cover

As noted in Section 2.1.5, the onsite and offsite staging areas in Young's Creek will allow sediment/soil to be dewatered at a rate of approximately 1,000 m^3/day. This dewatering rate results in approximately 200 excavation days and 70 excavation days, respectively, being required for the onsite and offsite portions of Young's Creek.

However, the four-year schedule for the Young's Creek Area (Figure 2-30) cleanup allows for up to a maximum of approximately 340 and 200 excavation days for the onsite and offsite areas of Young's Creek, respectively. Section 2.4.5 also noted that the additional time available in the four-year schedule, if needed, provides a "buffer" in the event that excavation or excavation and dewatering activities take longer than estimated, due to an actual average dewatering rate of less 1,000 m^3/day, inclement weather conditions, or difficult working conditions in the Young's Creek Basin, particularly in the offsite portion where the water depth of the three ponds is generally deeper than the water depth in the onsite portion of Young's Creek.

It is considered that the cleanup of the Young's Creek Area can be feasibly completed in a shorter duration, over three years. In this case, approximately 240 and 140 excavation days are available for the onsite and offsite areas of Young's Creek, respectively (see Figure 3-1). These periods have a smaller "buffer" allowance than the four-year schedule, however, are still greater than the 200 and 70 excavation days, respectively, required for the onsite and offsite portions of Young's Creek. The periods of work available in the three-year schedule, if completely used, are equivalent to achieving average reduced dewatering rates of approximately 833 m^3/day and 500 m^3/day for the onsite and offsite areas of Young's Creek.

3.3 Integrated Cleanup Schedule

The prioritization and optimization of the integrated cleanup has resulted in the three-year integrated schedule, as presented in Figure 3-1. The three-year integrated cleanup schedule is based on the assumption that provincial funding made available to the MOE will be able to meet the cashflow forecast of capital costs presented in Section 5.

The three-year integrated schedule is subject to MOE's funding being able to meet the cash flow projection presented in Section 5.

The benefits of a three-year integrated cleanup schedule include:

- While the average annual cleanup cost will be greater for a three-year program versus a four-year or five-year program, the total cleanup cost should be lower for a shorter program due to less escalation in contractor's costs, a more "focused" program, and lower project management costs
- A three-year cleanup program will allow the environmental and site restoration benefits to accrue earlier, including benefits to the local community and downstream, and reduce the Provincial liability associated with the Deloro Mine Site

While undertaking the cleanup of the Deloro Mine Site on an accelerated schedule, worker health and safety, community and environmental protection will be paramount, and must not be compromised during the cleanup activities. Health and safety and environmental controls are described in detail in the four Closure Plans and are summarized in Section 6.

4. Progress of Site-Wide Cleanup

Work packages that will be addressed or implemented on an annual basis, as part of the site-wide cleanup, as well as the progress of the site-wide cleanup over the hypothetical three-year period, as the shortest feasible construction period, are shown in the following figures:

- Figure 4-1: end of year one (2007)
- Figure 4-2: end of year two (2008)
- Figure 4-3: end of year three (2009)

These three figures were developed based on the three-year integrated cleanup schedule presented in Section 3. The estimated years of work shown above are based on the projected schedule to complete Stage 1 (see Figure 8-1 which shows that Stage 1 is estimated to be completed in the Fall of 2006, meaning that the Stage 2 cleanup could commence in the next available "construction season" in 2007).

- Figure 4-1 shows the following cleanup activities are anticipated to be completed in Year 1 (Phase I) in 2007:
  - IA-WP#1: Site Preparation
  - IA-WP#6.1: Clay Berm Around Perimeter of Equalization Pond
  - IA-WP#2.1: Demolition of Buildings and Tanks
  - IA-WP#2.2: Resizing and Consolidation of Ruins
  - IA-WP#3: Riverbank Reconstruction
  - IA-WP#6.2: Place 500-mm Clay Cover over Riverbank Wastes (bottom layer of engineered cover)
  - TA-WP#1: Site Preparation
  - TA-WP#2: Placement of Rip/Rap and Geotextile
  - TA-WP#3a: Installation of Engineered Cap, Interceptor Ditch, Drainage Ditches, and Planting of Grass
  - YC-WP#1a: Construction of Stage 1 Containment Cell Liner System
  - YC-WP#2a: Excavation of Onsite Contaminated Sediment and Soil, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)
- Figure 4-2 shows the following cleanup activities are anticipated to be completed in Year 2 (Phase II) in 2008:
  - IA-WP#4: Consolidation of Highly Leachable/Hazardous Wastes
  - IA-WP#5: Simple Earth (Clay) Cap Placement
  - IA-WP#6.3: Completion of 500-mm Clay Cover (bottom layer of engineered cover) over Wastes from Northern Industrial Area and Main Mine Area
  - IA-WP#6.4: Completion of 500-mm Clay Cover (bottom layer of engineered cover) over Wastes from Southern Industrial Area

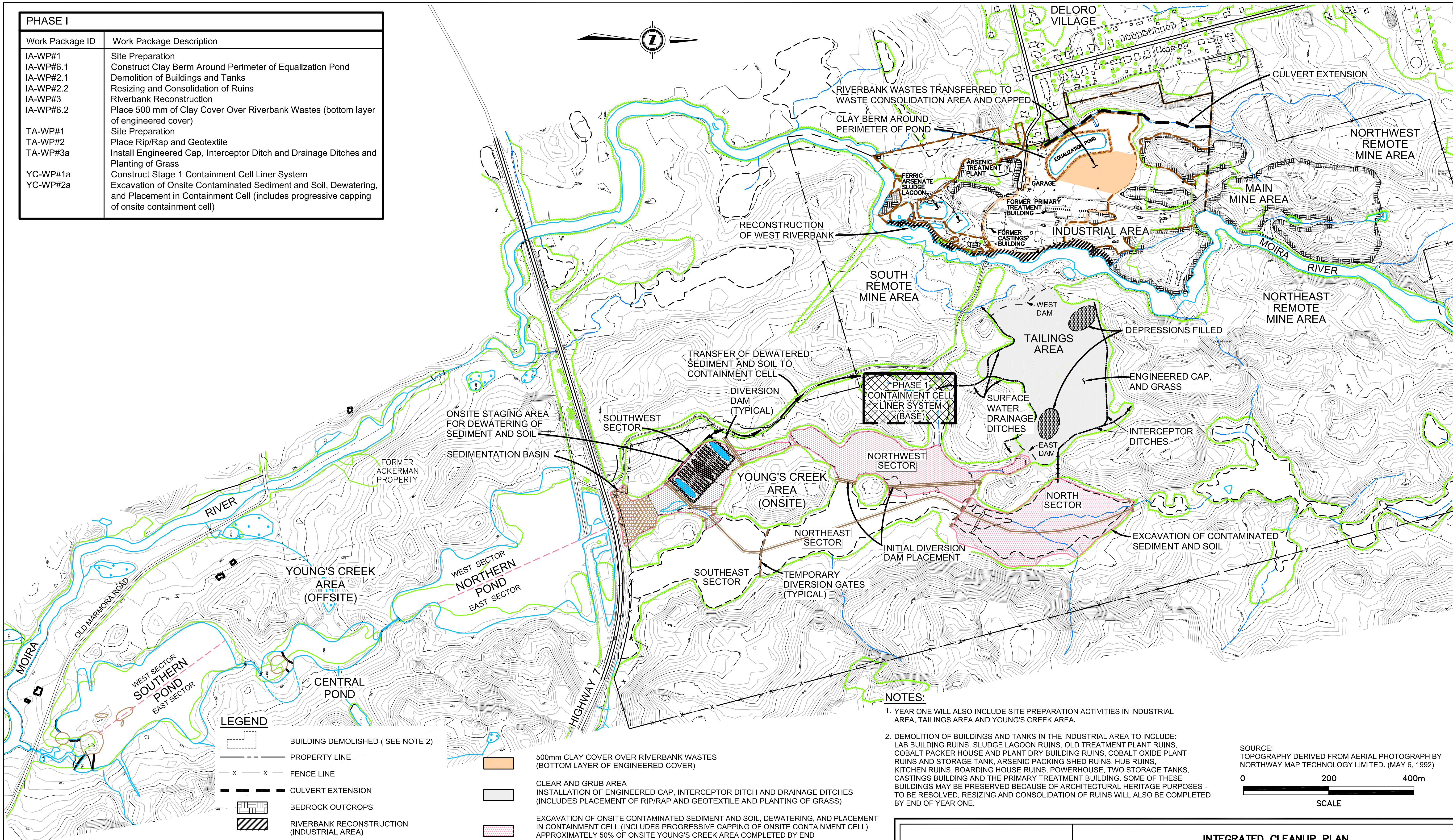
- MMA-WP #1a: Excavation of Highly Leachable Waste and Low-Level Radioactive Slag, and Infill/Vegetate and Reconstruct Riverbank (if required)
- RMA-WP #1b: Excavation of Impacted Soils and Infill/Vegetate
- MMA-WP #2a: Cover Waste Rock and Marginally Leachable Soil, and Vegetate
- RMA- WP #2b: Cover Waste Rock and Vegetate
- TA-WP#3b: Installation of Irrigation System and Poplar Tree Plantation
- YC-WP#1b: Construction of Stage 2 Containment Cell Liner System
- YC-WP#2b: Excavation of Remaining Onsite Contaminated Sediment and Soil, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)

- Figure 4-3 shows the following cleanup activities are anticipated to be completed in Year 3 (Phase III) in 2009:
  - IA-WP#6.5: Placement of Remaining Layers of Engineered Cover
  - IA-WP#7: Installation of Groundwater Interceptor Well Network
  - IA-WP#8: Revegetation of Simple Earth (Clay) Cap and Engineered Cover
  - MMA-WP #3: Upgrade of Tuttle Shaft Pumping System Installation, including Overland Piping to Industrial Area
  - TA-WP#4: Drilling of Seepage/Groundwater Collection Wells and Installation of Power Supply, Pumps, Heated Enclosure, and Overland Piping to Industrial Area
  - YC-WP#3: Onsite Creek Rehabilitation
  - YC-WP#4: Excavation of Offsite Contaminated Sediment, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)
  - YC-WP#5: Offsite Creek Rehabilitation

23/AUG/2004

PHASE I

Work Package ID	Work Package Description
IA-WP#1	Site Preparation
IA-WP#6.1	Construct Clay Berm Around Perimeter of Equalization Pond
IA-WP#2.1	Demolition of Buildings and Tanks
IA-WP#2.2	Resizing and Consolidation of Ruins
IA-WP#3	Riverbank Reconstruction
IA-WP#6.2	Place 500 mm of Clay Cover Over Riverbank Wastes (bottom layer of engineered cover)
TA-WP#1	Site Preparation
TA-WP#2	Place Rip/Rap and Geotextile
TA-WP#3a	Install Engineered Cap, Interceptor Ditch and Drainage Ditches and Planting of Grass
YC-WP#1a	Construct Stage 1 Containment Cell Liner System
YC-WP#2a	Excavation of Onsite Contaminated Sediment and Soil, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)



LEGEND

- BUILDING DEMOLISHED (SEE NOTE 2)
- PROPERTY LINE
- FENCE LINE
- CULVERT EXTENSION
- BEDROCK OUTCROPS
- RIVERBANK RECONSTRUCTION (INDUSTRIAL AREA)
- TRUCK HAUL ROUTE
- STAGING AREA
- 500mm CLAY COVER OVER RIVERBANK WASTES (BOTTOM LAYER OF ENGINEERED COVER)
- CLEAR AND GRUB AREA INSTALLATION OF ENGINEERED CAP, INTERCEPTOR DITCH AND DRAINAGE DITCHES (INCLUDES PLACEMENT OF RIP/RAP AND GEOTEXTILE AND PLANTING OF GRASS)
- EXCAVATION OF ONSITE CONTAMINATED SEDIMENT AND SOIL, DEWATERING, AND PLACEMENT IN CONTAINMENT CELL (INCLUDES PROGRESSIVE CAPPING OF ONSITE CONTAINMENT CELL) APPROXIMATELY 50% OF ONSITE YOUNG'S CREEK AREA COMPLETED BY END OF YEAR ONE.

NOTES:

1. YEAR ONE WILL ALSO INCLUDE SITE PREPARATION ACTIVITIES IN INDUSTRIAL AREA, TAILINGS AREA AND YOUNG'S CREEK AREA.
2. DEMOLITION OF BUILDINGS AND TANKS IN THE INDUSTRIAL AREA TO INCLUDE: LAB BUILDING RUINS, SLUDGE LAGOON RUINS, OLD TREATMENT PLANT RUINS, COBALT PACKER HOUSE AND PLANT DRY BUILDING RUINS, COBALT OXIDE PLANT RUINS AND STORAGE TANK, ARSENIC PACKING SHED RUINS, HUB RUINS, KITCHEN RUINS, BOARDING HOUSE RUINS, POWERHOUSE, TWO STORAGE TANKS, CASTINGS BUILDING AND THE PRIMARY TREATMENT BUILDING. SOME OF THESE BUILDINGS MAY BE PRESERVED BECAUSE OF ARCHITECTURAL HERITAGE PURPOSES - TO BE RESOLVED. RESIZING AND CONSOLIDATION OF RUINS WILL ALSO BE COMPLETED BY END OF YEAR ONE.

SOURCE:
TOPOGRAPHY DERIVED FROM AERIAL PHOTOGRAPH BY NORTHWAY MAP TECHNOLOGY LIMITED. (MAY 6, 1992)

0 200 400m
SCALE

CH2MHILL

PROJECT No. 119548

INTEGRATED CLEANUP PLAN

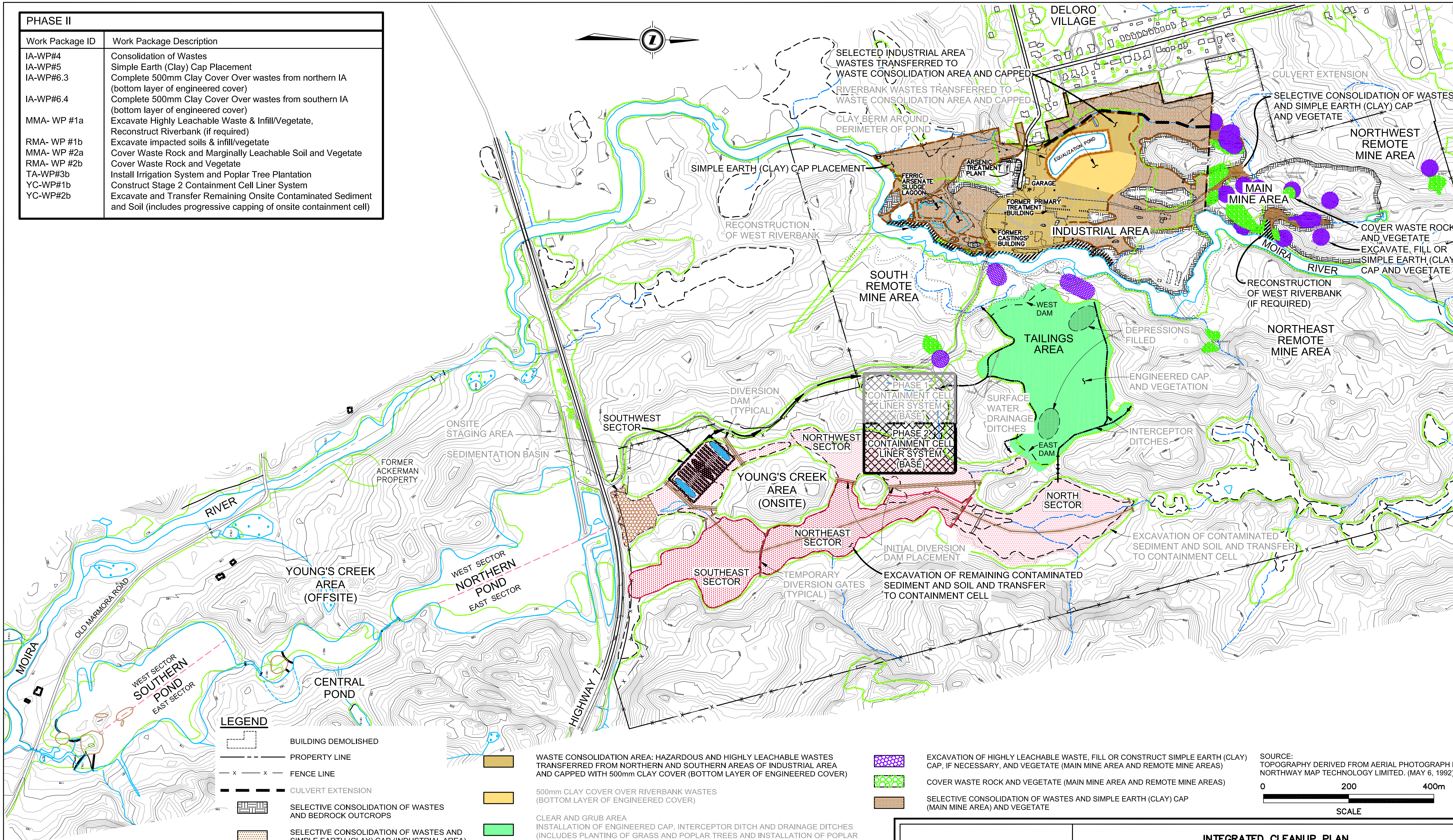
FIGURE 4-1
REMEDIATION ACTIVITY PLAN
END OF PHASE I (2007)

44246F197

23/AUG/2004

PHASE II

Work Package ID	Work Package Description
IA-WP#4	Consolidation of Wastes
IA-WP#5	Simple Earth (Clay) Cap Placement
IA-WP#6.3	Complete 500mm Clay Cover Over wastes from northern IA (bottom layer of engineered cover)
IA-WP#6.4	Complete 500mm Clay Cover Over wastes from southern IA (bottom layer of engineered cover)
MMA- WP #1a	Excavate Highly Leachable Waste & Infill/Vegetate, Reconstruct Riverbank (if required)
RMA- WP #1b	Excavate impacted soils & infill/vegetate
MMA- WP #2a	Cover Waste Rock and Marginally Leachable Soil and Vegetate
RMA- WP #2b	Cover Waste Rock and Vegetate
TA-WP#3b	Install Irrigation System and Poplar Tree Plantation
YC-WP#1b	Construct Stage 2 Containment Cell Liner System
YC-WP#2b	Excavate and Transfer Remaining Onsite Contaminated Sediment and Soil (includes progressive capping of onsite containment cell)



LEGEND

	BUILDING DEMOLISHED
	PROPERTY LINE
	FENCE LINE
	CULVERT EXTENSION
	SELECTIVE CONSOLIDATION OF WASTES AND BEDROCK OUTCROPS
	SELECTIVE CONSOLIDATION OF WASTES AND SIMPLE EARTH (CLAY) CAP (INDUSTRIAL AREA)
	RIVERBANK RECONSTRUCTION (MAIN MINE AREA) - IF REQUIRED
	TRUCK HAUL ROUTE
	STAGING AREA
	WASTE CONSOLIDATION AREA: HAZARDOUS AND HIGHLY LEACHABLE WASTES TRANSFERRED FROM NORTHERN AND SOUTHERN AREAS OF INDUSTRIAL AREA AND CAPPED WITH 500mm CLAY COVER (BOTTOM LAYER OF ENGINEERED COVER)
	500mm CLAY COVER OVER RIVERBANK WASTES (BOTTOM LAYER OF ENGINEERED COVER)
	CLEAR AND GRUB AREA INSTALLATION OF ENGINEERED CAP, INTERCEPTOR DITCH AND DRAINAGE DITCHES (INCLUDES PLANTING OF GRASS AND POPLAR TREES AND INSTALLATION OF POPLAR TREE IRRIGATION SYSTEM AND PLACEMENT OF RIP/RAP AND GEOTEXTILE)
	EXCAVATION OF REMAINDER OF ONSITE CONTAMINATED SEDIMENT AND SOIL AND TRANSFER TO CONTAINMENT CELL (INCLUDES PROGRESSIVE CAPPING OF ONSITE CONTAINMENT CELL)
	EXCAVATION OF HIGHLY LEACHABLE WASTE, FILL OR CONSTRUCT SIMPLE EARTH (CLAY) CAP, IF NECESSARY, AND VEGETATE (MAIN MINE AREA AND REMOTE MINE AREAS)
	COVER WASTE ROCK AND VEGETATE (MAIN MINE AREA AND REMOTE MINE AREAS)
	SELECTIVE CONSOLIDATION OF WASTES AND SIMPLE EARTH (CLAY) CAP (MAIN MINE AREA) AND VEGETATE

SOURCE:
TOPOGRAPHY DERIVED FROM AERIAL PHOTOGRAPH BY NORTHWAY MAP TECHNOLOGY LIMITED. (MAY 6, 1992)

0 200 400m
SCALE

CH2MHILL

PROJECT No. 119548

INTEGRATED CLEANUP PLAN

FIGURE 4-2
REMEDIATION ACTIVITY PLAN
END OF PHASE II (2008)

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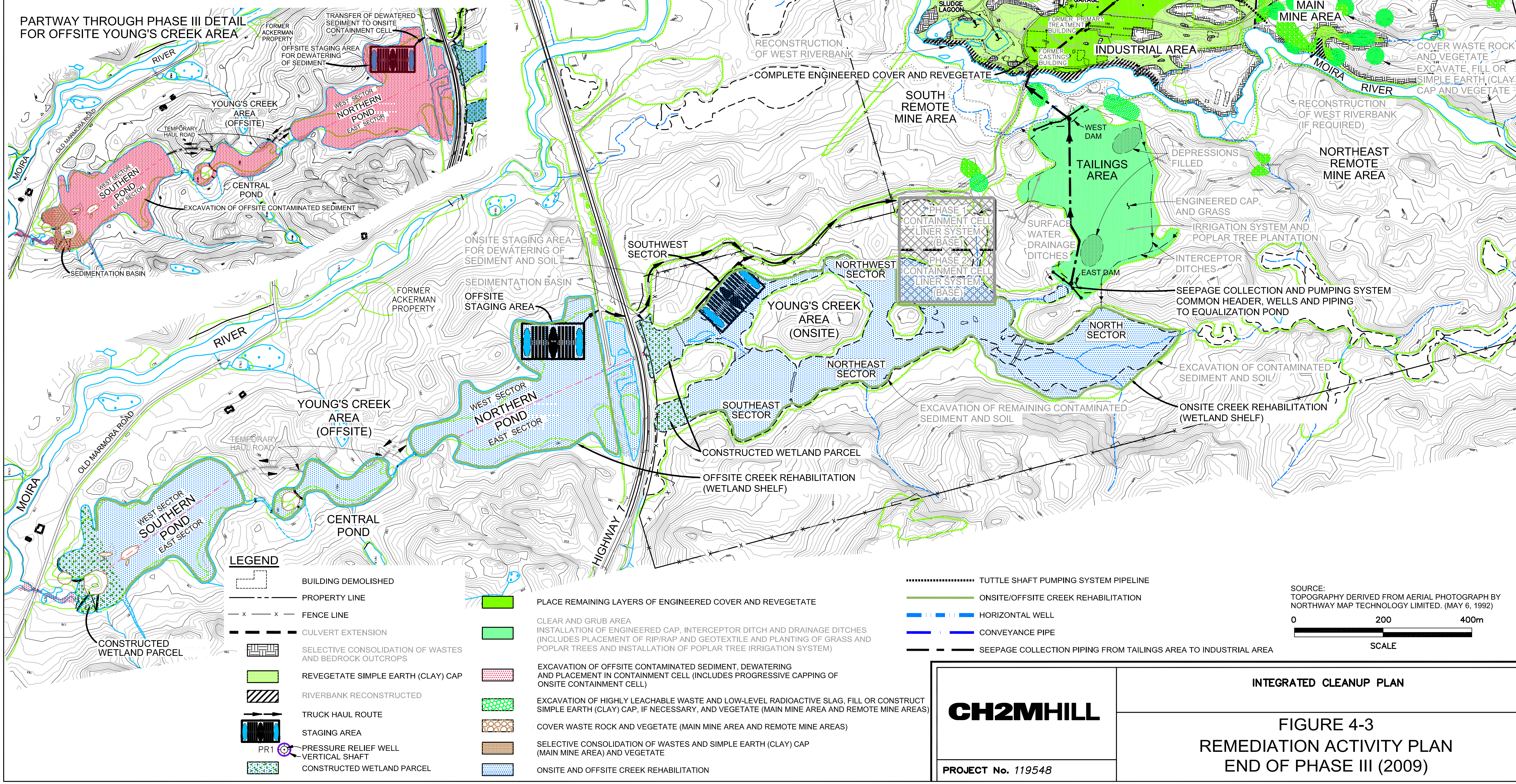
PHASE III	
Work Package ID	Work Package Description
IA-WP#6.5	Place Remaining Layers of Engineered Cover
IA-WP#7	Install Groundwater Interceptor Well Network
IA-WP#8	Revegetation of Simple Earth (Clay) Cap and Engineered Cover
MMA- WP #3	Upgrade Tuttle Shaft Pumping System Installation, and Install Overland Piping to Industrial Area.
TA-WP#4	Drill Seepage/Groundwater Collection Wells and Install Power Supply, Pumps, Heated Enclosures and Overland Piping to Industrial Area
YC-WP#3	Onsite Creek Rehabilitation
YC-WP#4	Excavation of Offsite Contaminated Sediment, Dewatering and Placement in Containment Cell (includes progressive capping of onsite containment cell)
YC-WP#5	Offsite Creek Rehabilitation



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PROJECT No. 119548

INTEGRATED CLEANUP PLAN

FIGURE 4-3
REMEDIATION ACTIVITY PLAN
END OF PHASE III (2009)

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5. Cost Opinion for Integrated Cleanup

A cost summary to implement the ICP is presented in Table 5.1. The cost summary is based on the costs presented in the four Closure Plans and the hypothetical three-year integrated cleanup schedule presented in Section 3.

The NPV costs presented in Table 5.1 are the sum of the capital cost and the net present value of the OMM costs. The total OMM costs have been transformed to a NPV of $14,673,021 assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

The cost opinion for the capital cost to undertake the site-wide cleanup is $37,757,892 in 2004 dollars with annual (weighted) OMM costs of $1,089,167. The NPV of this remediation work, assuming an effective interest of 5 percent and a planning horizon of 20 years is $52,430,914.

As noted in Section 2.1.4, consolidation, grading, and covering/capping of the Industrial Area will affect existing pumping stations, inspection holes, monitoring wells, and the overland forcemain from the Tuttle Shaft. The pumping stations, inspection holes, and monitoring wells will require modification to extend these to the new final grade. The existing forcemain from the Tuttle Shaft will be replaced with a new above ground pipeline (included in Table 5.1). The capital cost to undertake the other modifications in the Industrial Area are not included in Table 5.1 since related evaluation and design is beyond the scope of the ICP. The modifications required for the existing pumping stations, inspection holes, and monitoring wells will be addressed as part of final design.

The capital costs presented in Table 5.1 include overhead and remote location costs, a 15 percent contingency for the capital costs, a 5 percent contingency for the OMM costs, and the cost of insurance and various construction bonds associated with the work. The federal Goods and Services Tax (GST) has been excluded from the cost opinion (see below). The costs presented are expected to have accuracy on the order of +/-25 percent. The major assumptions used in making this cost estimate are provided in the four Closure Plans. The integrated costing has been completed at the preliminary design level and should be considered as a "cost opinion" to assist in budgeting. An appropriate allowance should be included in any budget planning to account for cost escalation factors for work after 2004. Costs can further be refined once the ICP has been accepted and the detailed design and approach have been finalized.

As shown in Table 5.1, the capital costs for the estimated years of cleanup are:

- Year 1 (2007): $14,745,735
- Year 2 (2008): $13,851,468
- Year 3 (2009): $9,160,689

Estimated Total Capital Cost: $37,757,892

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Table 5.1
Cost Summary to Implement Integrated Cleanup

Year	Work Package ID	Work Package Description	Cost	Insurance	Overhead	Performance Bond	Labour and Material Bond	Remote Area Cost	Final Costs*
Capital Costs									
Year 1 (2007)	IA-WP#1	Site Preparation	$ 703,164	$ 11,391	$ 27,423	$ 10,547	$ 10,547	$ 7,032	$ 770,105
	IA-WP#6.1	Construction of Clay Berm Around Perimeter of Equalization Pond	$ 69,552	$ 1,127	$ 2,713	$ 1,043	$ 1,043	$ 696	$ 76,173
	IA-WP#2.1	Demolition of Buildings and Tanks	$ 203,963	$ 3,304	$ 7,955	$ 3,059	$ 3,059	$ 2,040	$ 223,380
	IA-WP#2.2	Resizing and Consolidation of Ruins	$ 209,802	$ 3,399	$ 8,182	$ 3,147	$ 3,147	$ 2,098	$ 229,776
	IA-WP#3	Riverbank Reconstruction	$ 714,142	$ 11,569	$ 27,852	$ 10,712	$ 10,712	$ 7,141	$ 782,129
	IA-WP#6.2	Placement of 500-mm of Clay Cover Over Riverbank Wastes (bottom layer of engineered cover)	$ 82,271	$ 1,333	$ 3,209	$ 1,234	$ 1,234	$ 823	$ 90,103
	TA-WP#1	Site Preparation	$ 243,773	$ 3,949	$ 9,507	$ 3,657	$ 3,657	$ 2,438	$ 266,980
	TA-WP#2	Placement of Rip/Rap and Geotextile	$ 269,501	$ 4,366	$ 10,511	$ 4,043	$ 4,043	$ 2,695	$ 295,158
	TA-WP#3a	Installation of Engineered Cap, Interceptor Ditch, Drainage Ditches, and Planting of Grass	$ 5,540,817	$ 89,761	$ 216,092	$ 83,112	$ 83,112	$ 55,408	$ 6,068,303
	YC-WP#1a	Construction of Stage 1 Containment Cell Liner System	$ 3,021,705	$ 48,952	$ 117,846	$ 45,326	$ 45,326	$ 30,217	$ 3,309,371
	YC-WP#2a	Excavation of Onsite Contaminated Sediment and Soil, Dewatering and Placement in Containment Cell (includes progressive capping of onsite containment cell)	$ 2,405,275	$ 38,965	$ 93,806	$ 36,079	$ 36,079	$ 24,053	$ 2,634,257
Subtotal									**$ 14,745,735**
Year 2 (2008)	IA-WP#4	Consolidation of Highly Leachable/Hazardous Wastes	$ 785,060	$ 12,718	$ 30,617	$ 11,776	$ 11,776	$ 7,851	$ 859,798
	IA-WP#5	Simple Earth (Clay) Cap Placement	$ 3,459,377	$ 56,042	$ 134,916	$ 51,891	$ 51,891	$ 34,594	$ 3,788,710
	IA-WP#6.3	Completion of 500-mm Clay Cover Over Wastes from northern IA (bottom layer of Engineered Cover)	$ 651,784	$ 10,559	$ 25,420	$ 9,777	$ 9,777	$ 6,518	$ 713,834
	IA-WP#6.4	Completion of 500-mm Clay Cover Over Wastes from southern IA (bottom layer of Engineered Cover)	$ 273,434	$ 4,430	$ 10,664	$ 4,102	$ 4,102	$ 2,734	$ 299,465
	MMA-WP#1(a)	Excavation of Highly Leachable Wastes and Low-Level Radioactive Slag and Infill/Vegetate, and Reconstruct Riverbank (if required)	$ 949,297	$ 15,379	$ 37,023	$ 14,239	$ 14,239	$ 9,493	$ 1,039,670
	RMA-WP#1(b)	Excavation of Impacted Soils and Infill/Vegetate	$ 318,202	$ 5,155	$ 12,410	$ 4,773	$ 4,773	$ 3,182	$ 348,495
	MMA-WP#2(a)	Covering of Waste Rock and Marginally Leachable Soil, and Vegetate	$ 456,033	$ 7,388	$ 17,785	$ 6,840	$ 6,840	$ 4,560	$ 499,447
	RMA-WP#2(b)	Covering of Waste Rock and Vegetate	$ 115,417	$ 1,870	$ 4,501	$ 1,731	$ 1,731	$ 1,154	$ 126,405
	TA-WP#3b	Installation of Irrigation System and Poplar Tree Plantation	$ 211,846	$ 3,432	$ 8,262	$ 3,178	$ 3,178	$ 2,118	$ 232,014
	YC-WP#1b	Construction of Stage 2 Containment Cell Liner System	$ 3,021,705	$ 48,952	$ 117,846	$ 45,326	$ 45,326	$ 30,217	$ 3,309,371
	YC-WP#2b	Excavation of Remaining Onsite Contaminated Sediment and Soil, Dewatering and Placement in Containment Cell (includes progressive capping of onsite containment cell)	$ 2,405,275	$ 38,965	$ 93,806	$ 36,079	$ 36,079	$ 24,053	$ 2,634,257
Subtotal									**$ 13,851,468**
Year 3 (2009)	IA-WP#6.5	Placement of Remaining Layers of Engineered Cover	$ 1,895,885	$ 30,713	$ 73,940	$ 28,438	$ 28,438	$ 18,959	$ 2,076,373
	IA-WP#7	Installation of Groundwater Interceptor Well Network	$ 2,377,013	$ 38,508	$ 92,704	$ 35,655	$ 35,655	$ 23,770	$ 2,603,305
	IA-WP#8	Site Revegetation	$ 217,931	$ 3,530	$ 8,499	$ 3,269	$ 3,269	$ 2,179	$ 238,678
	MMA-WP#3	Upgrade of Tuttle Shaft Pumping System Installation, and Installation of Overland Piping to Industrial Area	$ 65,031	$ 1,054	$ 2,536	$ 975	$ 975	$ 650	$ 71,222
	TA-WP#4	Drilling of Seepage/Groundwater Collection Wells, and Installation of Power Supply, Pumps, Heated Enclosures, and Overland Piping to Industrial Area	$ 185,571	$ 3,006	$ 7,237	$ 2,784	$ 2,784	$ 1,856	$ 203,238
	YC-WP#3	Onsite Creek Rehabilitation	$ 298,816	$ 4,841	$ 11,654	$ 4,482	$ 4,482	$ 2,988	$ 327,263
	YC-WP#4	Excavation of Offsite Contaminated Sediment, Dewatering, and Placement in Containment Cell (includes progressive capping of onsite containment cell)	$ 3,035,639	$ 49,177	$ 118,390	$ 45,535	$ 45,535	$ 30,356	$ 3,324,632
	YC-WP#5	Offsite Creek Rehabilitation	$ 288,512	$ 4,674	$ 11,252	$ 4,328	$ 4,328	$ 2,885	$ 315,978
Subtotal									**$ 9,160,689**
Total Capital Costs									**$ 37,757,892**
Operation, Maintenance, and Monitoring Costs (Net Present Value for 20 years at effective interest rate of 5 percent)									
		Industrial Area OMM	$ 11,263,604 ($903,821)**	NA	$ 439,281	NA	NA	$ 112,636	$ 11,815,521
		Remote and Main Mine Area OMM	$ 978,993 ($62,522)**	NA	$ 38,181	NA	NA	$ 9,790	$ 1,026,964
		Tailings Area OMM	$ 1,154,290 ($84,000)**	NA	$ 45,017	NA	NA	$ 11,543	$ 1,210,850
		Young's Creek Area OMM	$ 590,739 ($38,824)**	NA	$ 23,039	NA	NA	$ 5,907	$ 619,686
Net Present Value OMM Costs			$ 13,987,627	NA	$ 545,517	NA	NA	$ 139,876	**$ 14,673,021**
Net Present Value of Capital and OMM Costs			$ 48,463,424	$ 558,508	$ 1,890,074	$ 517,137	$ 517,137	$ 484,634	**$ 52,430,914**

All capital costs exclude GST. A 15 percent contingency is included in the capital costs (before taxes, overhead, insurance, and bonds).
All OMM costs exclude GST. A 5 percent contingency is included in the OMM costs (before taxes).
*All costs have been developed using 2004 pricing and do not include an escalation factor.
**Annual (Weighted) OMM Costs (before overhead and remote area cost).

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Therefore, similar capital costs are estimated for the first two years of the cleanup, at approximately 39 percent and 37 percent of the total capital cost in 2007 and 2008, respectively. By Year 3, in 2009, the value of the cleanup will decline to approximately 24 percent of the total capital cost.

The capital costs and OMM costs for the key areas of the site are presented in the following tables:

- Industrial Area: Table 5.2
- Mine Area: Table 5.3
- Tailings Area: Table 5.4
- Young's Creek Area: Table 5.5

The capital costs and OMM costs presented in the four Closure Plans are greater than the amounts shown in Tables 5.2 through 5.5 since the Closure Plan costs included GST. The MOE is exempt from paying GST; hence, this tax has not been included in Tables 5.2 through 5.5.

TABLE 5.2
INDUSTRIAL AREA COSTS

Work Package Identification #		Description	Estimated Cost* (2004 dollars)
Capital Cost Items			
IA-WP#1		Site Preparation	$770,105
IA-WP#2		Demolition	$453,156
IA-WP#3		Riverbank Reconstruction	$782,129
IA-WP#4		Consolidation of Wastes	$859,798
IA-WP#5		Simple Earth (Clay) Cap	$3,788,710
IA-WP#6		Engineered Cover	$3,255,949
IA-WP#7		Groundwater Interceptor Well Network	$2,603,305
IA-WP#8		Site Revegetation	$238,677
Total Capital Costs			**$12,751,829**
OMM Cost Items (Annual Weighted Annual Costs)			
IA-OMM#1			
	1.1	Arsenic Treatment Plant Operations	$577,371
	1.2	Sludge Disposal (assuming 550 tonnes/year)	$166,711
	1.3	Site Maintenance and Monitoring	$134,839
	1.4	Groundwater Interceptor Well Network OMM	$24,900
Total Average Weighted Annual OMM Cost			**$903,821**
NPV OMM Costs			**$11,815,521****
NPV of Capital and OMM Costs			**$24,567,350**

*All costs have been developed using 2004 pricing and do not include an escalation factor.
**NPV of Annual OMM Costs using an effective interest rate of 5 percent, and a planning horizon of 20 years.

TABLE 5.3
MINE AREA COSTS

Work Package Identification #	Description	Estimated Cost* (2004 dollars)
Capital Cost Items		
MMA-WP#1a	Excavate Highly Leachable Wastes, Radioactive Slag, and Infill/Vegetate and Reconstruct Riverbank (if required)	$1,039,670
RMA-WP#1b	Excavate Impacted Soils and Infill/Vegetate	$348,495
MMA-WP#2a	Cover Waste Rock, Consolidate/Cover Marginally Leachable Soils, and Vegetate	$499,447
RMA-WP#2b	Cover Waste Rock and Vegetate	$126,405
MMA-WP#3	Upgrade Tuttle Shaft Pumping System Installation and Install Overland Piping to Industrial Area	$71,222
Total Capital Costs		**$2,085,239**
OMM Cost Items (Average Weighted Annual Costs)		
Total Average Weighted Annual OMM Cost		**$62,522****
NPV OMM Costs		**$1,026,964*****
NPV of Capital and OMM Costs		**$3,112,203**

*All costs have been developed using 2004 pricing and do not include an escalation factor.
**Includes OMM of Tuttle Shaft pumping, maintenance of capping, and monitoring program.
***NPV of averaged weighted annual OMM costs using an effective interest rate of 5 percent, and a 20-year planning horizon.

TABLE 5.4
TAILINGS AREA COSTS

Work Package Identification #	Description	Estimated Cost* (2004 dollars)
Capital Cost Items		
TA-WP#1	Site Preparation	$266,980
TA-WP#2	Placement of Rip Rap and Geotextile	$295,157
TA-WP#3a and 3b	Installation of Engineered Cap (clay, sand, HDPE perforated collection pipe, silty loam, topsoil, and grass) and Interceptor and Drainage Ditches; Installation of Poplar Plantation and Irrigation System	$6,300,316
TA-WP#4	Tailings Seepage and Groundwater Pumping and Piping System	$203,238
Total Capital Costs		**$7,065,691**
OMM Cost Items (Average Weighted Annual Costs)		
TA-OMM#1	OMM Program	$84,000
Total Average Weighted Annual OMM Cost		**$84,000**
NPV OMM Costs		**$1,210,850****
NPV of Capital and OMM Costs		**$8,276,541**

*All costs have been developed using 2004 pricing and do not include an escalation factor.
**Net Present Value (NPV) of Annual OMM Costs using an effective interest rate of 5 percent, and a 20-year planning horizon.

TABLE 5.5
YOUNG'S CREEK AREA COSTS

Work Package Identification #	Description	Estimated Cost * (2004 dollars)
Capital Cost Items		
YC-WP#1	Containment Cell Liner System Construction	$6,618,743
YC-WP#2	Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell (includes cap construction)	$5,268,515
YC-WP#3	Onsite Creek Rehabilitation	$327,263
YC-WP#4	Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell (includes cap construction)	$3,324,632
YC-WP#5	Offsite Creek Rehabilitation	$315,978
Total Capital Costs		**$15,855,131**
OMM Cost Items (Average Weighted Annual Costs)		
Total Average Weighted Annual OMM Cost		**$38,824****
NPV OMM Costs		**$619,685*****
NPV of Capital and OMM Costs		**$16,474,816**

* All costs have been developed using 2004 pricing and do not include an escalation factor.
** Includes removal of leachate from holding tank, monitoring program, and maintenance of containment cell and wetlands.
***NPV of average weighted annual OMM costs using an effective interest rate of 5 percent and a planning horizon of 20 years.

6. Health Safety and Environmental Controls

Protection of public health and the environment is of paramount concern throughout and following the physical work proposed for the Deloro Mine Site Cleanup. Public health is viewed to encompass worker health and protection for individuals engaged in the cleanup activities, as well as protection for residents near the site. This includes people living in the Village of Deloro and downstream along the Moira River. Environmental protection includes identifying risks related to potential releases during the cleanup whether through liquid releases to the Moira River, spillage of wastes during relocation, or dust/air emissions as a result of physical work at the site. The ICP outlines the provisions that are proposed as part of this comprehensive plan. This includes provisions for containment, monitoring, and mitigation. A number of specific plans are proposed to address various aspects of the identified health, safety, and environmental risks.

6.1 Site Security and Safety

At present, as shown in Figure 6-1, the Deloro Mine Site and the OCWA compound are completely enclosed by a 7,606 m perimeter fence that was installed in March 2000 (CH2M HILL, October 2003c). The majority of the chain link perimeter fence was installed to a height of 2.13 m, including 0.30 m of barbed wire. Adjacent to Highway 7, the perimeter fence was installed to a height of 2.13 to 2.44 m, without barbed wire to satisfy Ministry of Transportation’s Permit requirements.

There are seven points of entry to the site, mainly along the southern and western property boundaries, including five 9.0-m wide gates (includes one 9.0-m wide gate installed in 2003), one 6.0-m wide gate, and one 1.2-m wide gate. Access gates will remain closed if not in use during the day, and all gates will be closed and locked at the end of each working day to prevent public access to the site during remediation activities.

Access to the Industrial Area and portions of the Mine Area, along the west side of the Moira River, will be through the main site access gate near the ATP. The existing onsite access road will be used for construction vehicles to access these areas.

Access to the Tailings Area and the Young’s Creek Area onsite will be via the access road off Highway 7. Prior to work being conducted in the offsite portion of Young’s Creek, a 1.8-m high chain link fence will be installed around the perimeter of the offsite portion of Young’s Creek near key access points (i.e. road areas or other areas where a higher potential for public access exists). In other more remote and inaccessible areas, it will be determined during the final remedial design if temporary fencing is sufficient or required to further restrict public access to the work area. Any temporary perimeter security fencing erected during the implementation of the project will be removed.

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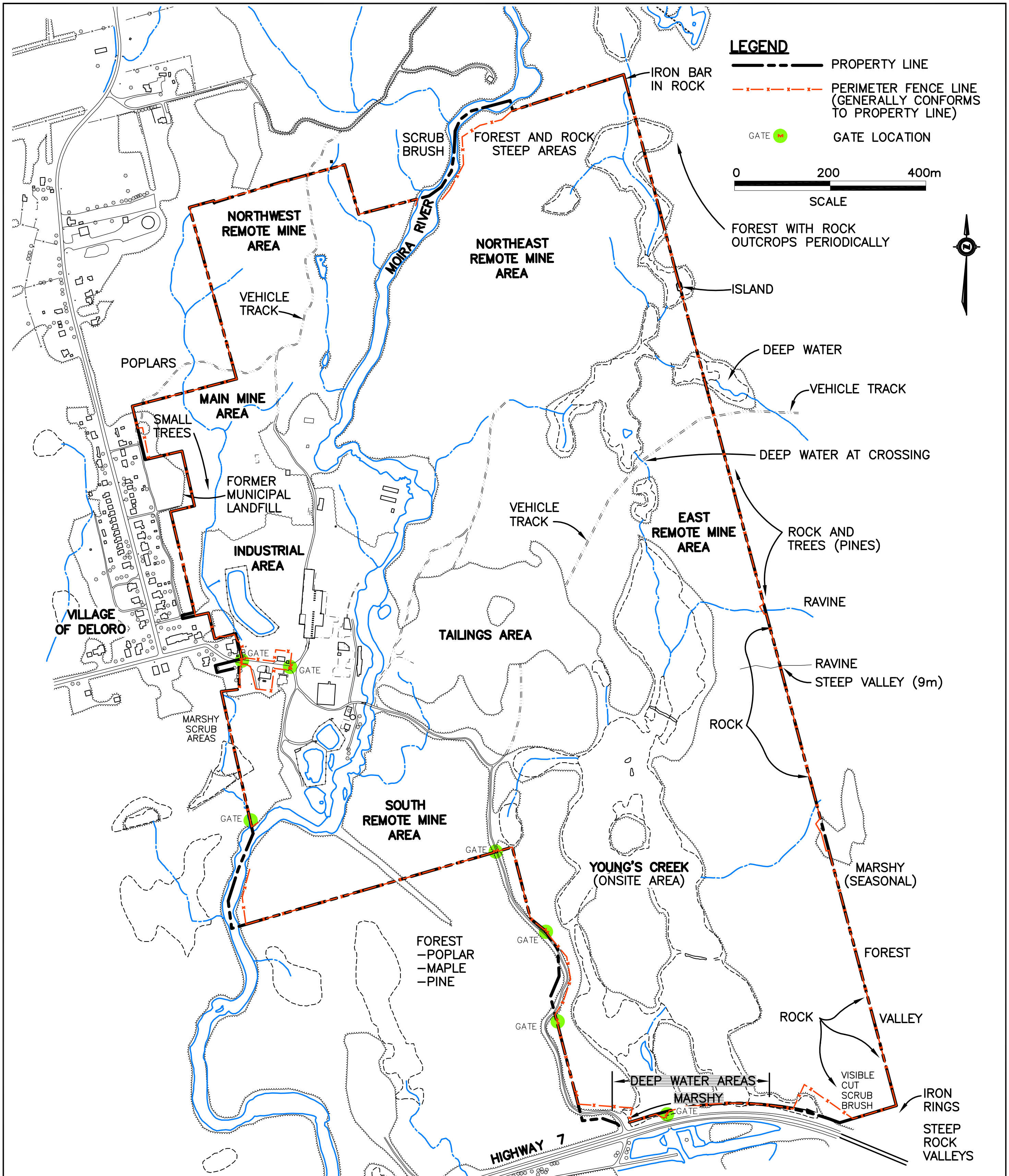

CH2MHILL

PROJECT No. 119548

INTEGRATED CLEANUP PLAN

FIGURE 6-1
PLAN OF PERIMETER FENCE

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A group of three signs are affixed to the existing fence at distances varying between 50 m and 200 m, which read as follows:

- *Danger, No Trespassing, Positively No Admittance* (25 cm by 36 cm)
- *Caution, Radiation Area, Radioactive Materials, Authorized Personnel Only* (25 cm by 36 cm)
- *Mine Hazard Area, Danger: Every person who alters, impairs, or destroys this notice, this fence or any rehabilitation work made in accordance with Part VIII of the Mining Act, is guilty of an offence and, upon conviction, is liable to a fine of not more than $30,000* (30 cm by 30 cm)

During the construction phase of the project, signs would be used to caution the public along Highway 7, in the Village of Deloro, and at site entrances. Signage may include "*Trucks Turning*" and other construction warning signs, as well as "*Danger – Access By Permit Only*" at access gates. Additionally, flagmen may be needed along Highway 7 to control traffic when heavy machinery or large transport trucks enter or exit the highway.

An assessment and reconstruction of the onsite bridge crossing the Moira River was recently completed as reported in CH2M HILL's report entitled, *Deloro Mine Rehabilitation Project – Assessment and Reconstruction of Deloro Mine Site Bridge, Final Report* (CH2M HILL, June 2002). It was concluded that the bridge is not suitable for "heavy" construction vehicles which will effectively isolate "heavy" construction activities on the west and east sides of the river.

6.2 Health Hazard Assessment

A document entitled *Deloro Mine Rehabilitation Project – General Health and Safety Plan (GHASP), Final Report* (CH2M HILL, January 2002) has been developed to identify the main hazards and to provide a basis for the health and safety protocols.

The GHASP identifies the following health hazards associated with the Deloro Mine Site, that could be encountered while undertaking site inspections, site investigations, and remedial cleanup:

- Arsenic and arsenic compounds, other metals, and silica
- Radiological hazards
- Heat and cold stress
- Buried utilities
- General physical (safety) hazards
- Biological hazards
- Chemicals existing at or brought onto site

The GHASP outlines and describes appropriate procedures and protocols to effectively deal with the above hazards associated with the Deloro Mine Site. The GHASP addresses hazard evaluation and control procedures and protocols (including action levels), personal protective equipment to be used, air monitoring protocols and specifications, decontamination procedures and protocols, spill containment procedures, confined space entry procedures, emergency response plans, and emergency contacts.

If not already addressed, addenda to the GHASP will be developed to address hazards associated with specific work packages identified in the Closure Plans.

For instance, the health hazard to workers will be greatest during the handling of wastes and the construction of the engineered cover. Addenda will identify specific procedures for work in these types of conditions.

Radiological hazards result from radioactive slag, some tailings-like material in the Industrial Area, and sediments in the onsite Young's Creek Area contaminated by radium and uranium tailings eroded from the Tailings Area. The slag represents an external hazard from radiation fields, whereas the tailings-like material and sediments represent both external hazards due to radiation fields and internal hazards from potential ingestion and/or inhalation during the handling activities. Although ambient radiation fields in most of the work areas are expected to be below 1 μSv/h, standard radiation protection procedures, as described in the GHASP, will be employed to minimize doses to workers during the various remediation activities. Routine radiation field monitoring will be used to identify those areas in which radiation protection procedures must be implemented. Contamination control procedures will also be implemented, as described in the GHASP. Decontamination procedures are outlined in Section 6.4.2 of this report.

In addition to the above, each contractor working on the site will be responsible for the safety of their own crew and will be required to develop a Health and Safety (H&S) Plan for their specific work as part of the contract requirements. A dedicated CH2M HILL H&S Coordinator will be onsite during all periods of major activity to ensure that plans are adhered to. In addition, the H&S Coordinator will be responsible for providing H&S briefings to all workers and obtaining their sign-off that they have received the briefings.

6.3 Environmental and Community Health Protection Plan

Potential receptors that could be affected by the cleanup of the Deloro Mine Site include workers involved in the site cleanup, residents in the Village of Deloro, residents and cottagers along the Moira River downstream of the site, and vehicular traffic along Highway 7 near Young's Creek (in the case of impacted materials being transported onsite from offsite Young's Creek across Highway 7). The following Environmental and Community Health Protection Plan (ECHPP) identifies potential risks associated with the cleanup of the site and recommends appropriate mitigation measures. Protection of workers involved in the Deloro Mine Site cleanup was addressed in the previous section.

The disturbance of potentially contaminated materials during remedial activities and the possible loss of contaminants from the work area depend to a high degree on the remedial methods and related physical activities undertaken during site rehabilitation. Since the transport of contaminants is most easily controlled at the source, the remedial activities selected for the site have been chosen based on the ability to minimize and control the disturbance, spread, and loss of contaminants from the work area. Additional actions can be taken to further limit the spread and loss of contaminants from the work area and potentially offsite. These include measures to control dust, noise, odours, surface water runoff, surface water run-on, and erosion, as well as the use of appropriate equipment and personnel decontamination procedures. Each of these measures, which are discussed briefly below, will be undertaken prior to and during implementation of the remedial activities. Odour control is not discussed since it is not expected to be of concern during implementation of remedial activities at the Deloro Mine Site.

It should be noted that this overview provides some of the key aspects associated with the mitigation and monitoring of potential offsite impacts resulting from remedial activities at the Deloro Mine Site. The finalized details and procedures will be included in the contract documents and specifications associated with the rehabilitation of the Deloro Mine Site, and the execution plans proposed by the remedial contractors who are selected to complete the cleanup work.

6.3.1 Dust Control and Air Monitoring

Effective dust control at sites undergoing remediation is best addressed via the development, establishment, implementation, and enforcement of a fugitive particulate emission control program. The development and implementation of such a program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The fugitive particulate emission control program includes a description of the procedures relating to the handling of materials, air monitoring and dust control, and is documented in the contractor's execution plan for the site remedial activities. The remedial contractor is required to take all precautions necessary to minimize and control the generation of dust, and under no circumstances will unacceptable levels of dust be permitted to be generated and/or transported offsite.

Key aspects of a fugitive particulate emission control program include:

- Conducting remedial activities that involve the disturbance of material, such as excavation, during good weather conditions in order to minimize the loss of materials by wind
- Moving materials directly to their designated location, rather than handling several times, in order to minimize the generation of dust (i.e. multiple handling tends to break materials into smaller and smaller pieces which are more likely to be entrained by wind)
- Ensuring adequate equipment and personnel are available at the site at all times to immediately clean up any spilled material, whether it be of a small or large amount
- Implementing an inspection program to monitor the condition of onsite and offsite roads, materials piles, vehicles, etc.
- Using tarps to cover materials which are likely to generate dust
- Using dust suppressants to control dust associated with roadways, work areas, stockpiles, and other possible sources. Materials used to assist in dust suppression might include water, calcium chloride, or latex binders. The frequency of application of dust suppressants is generally on an as-needed basis
- Regrading of unpaved roads, as required, to keep silt content below 10 percent, and the sweeping of paved roads
- Using tarps on trucks that transport materials onsite and offsite
- Monitoring air both upwind and downwind of the site in order to confirm that dust control measures are effective and to ensure that any potential offsite air quality impacts caused by remedial operations are minimized
- Determining the frequency of monitoring and locations of monitoring stations at the Deloro Mine Site following the development of the final ICP, and the review of the

contractor's execution plan, the proposed remedial activities, and meteorological conditions

- Conducting meteorological measurements (wind speed and direction) in conjunction with the air monitoring program. Typically, hourly and daily average wind speed and direction at one localized site could be required during site activities

Monitoring of ambient air quality prior to initiation of remedial activities at the Deloro Mine Site is recommended, and should be carried out on several occasions and under a variety of conditions in order to establish background air quality both onsite and offsite.

6.3.2 Noise Control

While noise is expected to be generated at the Deloro Mine Site during cleanup as a result of mobile sources such as truck and vehicular traffic, as well as equipment sources such as excavators, bulldozers, compactors, generators, pumps, and air compressors, conformation with regulatory requirements is not expected to be a major problem. The development and implementation of a noise monitoring and control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant prior to initiation of any site work. The contractor is usually required to provide written details of the noise monitoring and control program in their execution plan to ensure that local requirements are met.

Typical aspects of a noise monitoring and control program include:

- The contractor will be required to take all precautions necessary to minimize noise and under no circumstances will unacceptable levels of noise be permitted to impact offsite residents/property owners
- The contractor is to conduct all work using appropriate construction methods and equipment so that noise emanating from the site remains at acceptable levels
- The contractor is required to obtain approval from the owner and/or consultant prior to conducting any site activities between the hours of 6:00 p.m. and 7:00 a.m.
- The contractor will be required to undertake noise monitoring if deemed necessary
- MOE noise guidelines for landfill operations suggest that a criterion of 50 dBA during the hours of 7:00 a.m. and 7:00 p.m. should be established for the closest residential location. A similar guideline may be suitable for the cleanup activities at the Deloro Mine Site

6.3.3 Surface Water Protection

The control of surface water is required in order to minimize the contact of water with potentially contaminated materials and thus reduce the generation of contaminated water. This can be achieved though the control of surface water runoff from the work area, as well as the control of surface water run-on into the work area. Surface water is also required to be controlled in order to minimize erosion and prevent the offsite transport of potentially contaminated water and sediment to Young's Creek and the Moira River. Specific details relating to the control of surface water will be dependent on the final engineering designs for the cleanup of the site.

The development and implementation of a work area surface water control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. Generally, the remedial contractor is required to take all precautions necessary to minimize the generation of sediment and potentially contaminated surface water, and may be required to collect and treat any such water.

Key aspects of a work area surface water control program include:

- The use of geotextile silt fencing, sand bags, and/or straw bales to reduce sediment transport
- The construction of surface water diversions, comprised of swales and sumps or clay berms, to re-direct and/or collect surface water runoff and run-on
- The collection and treatment of all potentially contaminated water, including water used to decontaminate equipment, surface water, and water generated from the dewatering of excavations
- In the case of the Deloro Mine Site cleanup, surface runoff characteristics (i.e. quantity, quality, and direction of flow) of the site should be assessed prior to initiation of remedial activities. Additionally, an assessment of the quality of water in existing site drainage ditches and channels, including those that result in both run-on and runoff, standing water, and natural water (i.e. any adjacent natural streams, wetland areas, and the Moira River) should be undertaken prior to remedial activities (if not addressed through current site monitoring). The water quality assessment should include the sampling and analysis of water for total suspended solids, arsenic, and metals
- Once a decision on the activities planned for the Deloro Mine Site is made, a site-wide surface water quality monitoring program should be developed for implementation during the cleanup

6.3.4 Emergency Response and Preparedness

CH2M HILL will develop a site-specific emergency procedures plan including requirements and information relating to emergency contacts, directions to the nearest hospital, spill and fire control, emergency communications, emergency response such as for a spill or fire, medical emergency procedures, notification, and reporting. All site contractors will be expected to be familiar with and implement the site-specific emergency procedures plan as required. Much of this information is already contained in the GHASP (CH2M HILL, January 2002).

The emergency response plan will include procedures which address both preventive measures and response actions to conceivable emergencies as outlined below:

Transportation and Emergency Response Plan

CH2M HILL will develop a site Transportation and Emergency Response Plan (TERP) to outline procedures and protocols for addressing vehicular accidents and spills of hazardous and non-hazardous materials. Procedural controls will limit the speed of vehicles and determine safe routes.

All transport vehicles hauling contaminated soils shall be equipped with the following:

- A first aid kit
- A fire extinguisher
- A two-way radio or cellular telephone allowing direct communication between the driver and the contractor's superintendent
- Personal protective equipment (PPE) comprised of disposable coveralls and work gloves, CSA-approved safety glasses, hard hat, and safety boots
- A copy of or summary of the TERP

Equipment Monitoring and Decontamination. All equipment involved in the excavation, handling, and transportation of contaminated soils, including the haul vehicles, will be dedicated to the project until released after monitoring and decontamination (if necessary) (see Decontamination Procedures) to assure levels of radioactivity are not discernable from that of local background.

Payload Covers. Contaminated soils in haul vehicle boxes will be covered by tarpaulins (tarps). Tarps will be secured by tie-downs around the perimeter of the vehicle box. Standard retractable box covers will not be an acceptable alternative to fully secured tarps.

Haul Routes. A primary haul route will be identified for each phase of the project together with a secondary haul route should the primary route not be available. Alternatively, hauling may be temporarily suspended.

Tracking Systems. A tracking system will be implemented to document the site activity for the purposes of contract administration and the amount of impacted material that is relocated. This may involve the use of a trip ticket (i.e. manifest) system (or a similar process).

Response Plans. Specific response plans under the TERP will be developed for the range of scenarios that could occur during the rehabilitation works. Response plans are anticipated to be needed for the following scenarios, as a minimum:

- Breakdown or Accident Involving Release of Contaminated Soils
- Breakdown or Accident Involving Release of Fuels, Lubricants or Hydraulic Fluids
- Breakdown or Accident Not Involving Release of Contaminated Soils

Associated Considerations and Activities. Several issues associated with the mitigation of offsite impacts include:

- The development and implementation of specific work practices associated with contamination, decontamination, and clean work zones
- In addition to the existing perimeter fencing, the development and implementation of a site security plan including aspects such as additional fencing of work areas, warning/caution signs, security patrols, control of site staff and visitors, etc.
- The use of qualified environmental contractors who are experienced in similar types of projects, have a good safety and environmental record, and whose employees are experienced and qualified

6.4 Contamination Control

6.4.1 Work Zone Delineation

Areas of the site will be defined as Contaminated Zones, Transition Zones, Decontamination Zones, or Clean Zones. The Work Zone Delineation will be linked to, and form the basis for, the level of PPE required within each zone as defined in the H&S Plan for the site.

Contaminated Zones. Many areas of the site have various levels of contamination. These areas will be defined as being passive or active. An Active Contamination Zone or Exclusion Zone will be defined as an area where intrusive remediation works such as excavation or other activities that could create dust and fugitive emissions are ongoing. The Exclusion Zone is delineated by temporary perimeter fencing. A Passive Contamination Zone is defined as an area where no intrusive remediation work is ongoing or an area that is sufficiently controlled so as to ensure that no dusting or fugitive emissions are occurring. A Passive Contamination Zone could potentially be used as a Transition Zone, a Decontamination Zone, or a Clean Zone.

Transition Zones. A Transition Zone is the area of other facilities between the Exclusion Zone and the Decontamination Zone. In this zone, the workers will move either on foot or in a designated vehicle to a Decontamination Zone entrance where the workers' PPE will be removed and disposed of or decontaminated for re-use. The Transition Zone is usually defined by temporary fencing or red or yellow tape.

Decontamination Zones. The Decontamination Zone will be an area where personnel and equipment are decontaminated before leaving the site or moving to other areas of the site outside of the Exclusion Zone. This is discussed further under the section entitled, Decontamination Procedures.

Clean Zones. The Clean Zone is the balance of the site where no intrusive remedial work is ongoing and the risks for contact with contaminants is minimal. However, some areas of the site may be contaminated to a degree that they are not considered "clean" even if no intrusive remedial activity is ongoing. These areas will be designated as Passive Contamination Zones.

6.4.2 Decontamination Procedures

In order to prevent the transfer of contaminants from the work area, all equipment, materials, and supplies that come into contact with potentially contaminated materials must be decontaminated prior to removal from the work area or between work zones. The development and implementation of equipment decontamination procedures is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The remedial contractor is required to take all precautions necessary to minimize the transfer of contaminated materials from the work area. Under no circumstances is the transfer of non-decontaminated equipment and materials from the work area permitted.

The key aspects of an equipment decontamination program include:

- Decontamination of equipment and materials that have come into contact with potentially contaminated materials, completed by the contractor prior to the removal of equipment and materials from the work area/zone
- Equipment decontamination using water or steam facilities to decontaminate tracks, sprockets, tires, axles, buckets, and trailers used in the transport of materials

The facilities for equipment decontamination typically include a decontamination pad with a power washer equipped with an enclosure to collect overspray, water, and solids for subsequent management.

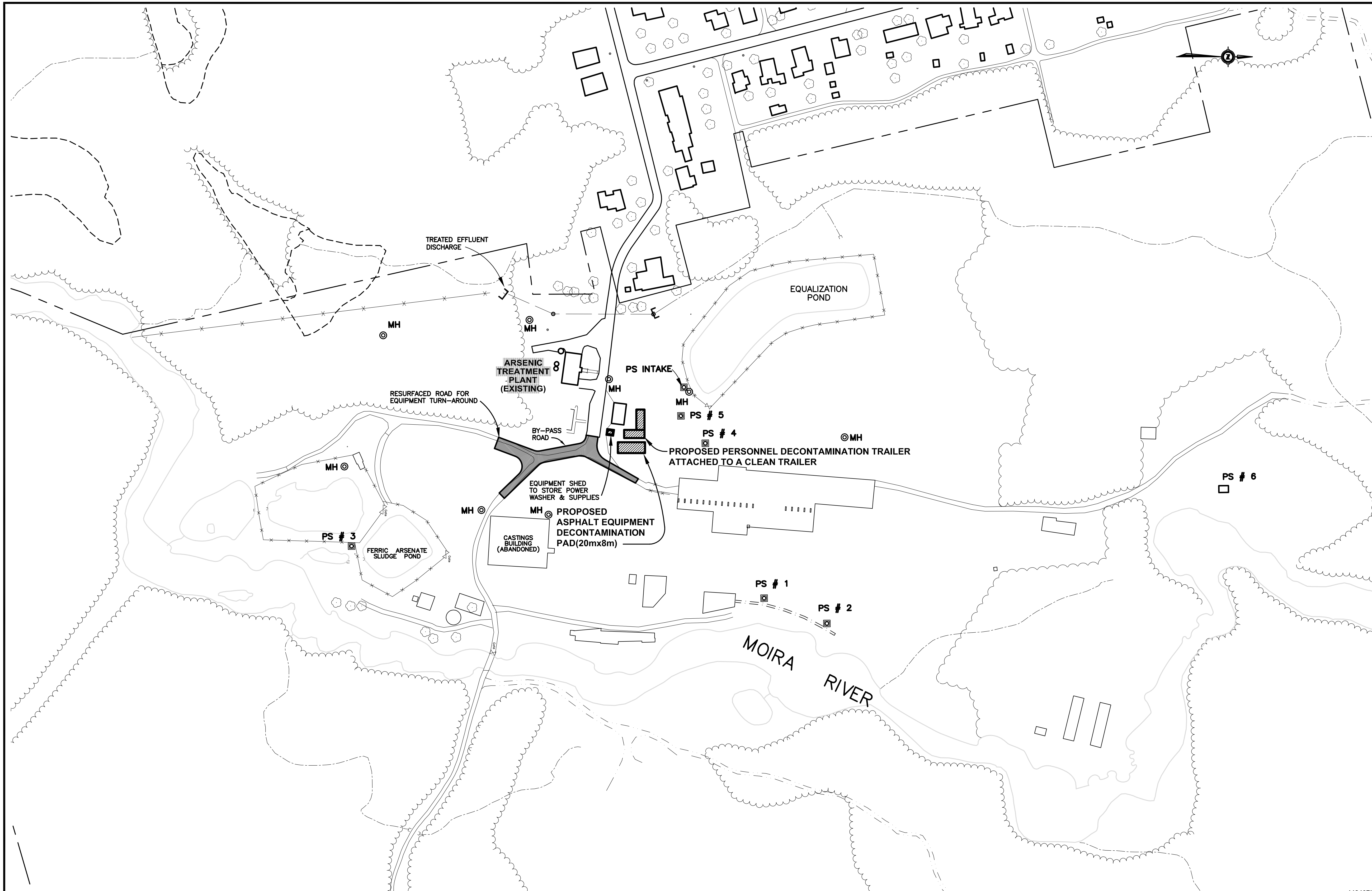
Decontamination will be required when equipment is transferred between the various types of work zones discussed above. All equipment will be thoroughly decontaminated at a centralized decontamination facility prior to leaving the site. The proposed location of the decontamination pad and related amenities is shown in Figure 6-2.

Similarly, facilities will be provided for personnel decontamination. These facilities will involve personnel hygiene facilities with change rooms and showers which are segregated into clean and dirty areas to mitigate the spread of contamination. A typical layout is indicated in Figure 6-3. The proposed location is adjacent to the equipment decontamination pad on Figure 6-2. These facilities are expected to be implemented for the duration of the project after which they will be dismantled. MOE has applied for and received an amended Certificate of Approval (C of A) for the decontamination facilities (see Table 7.1).

6.5 Other Operational Procedures

In order to prevent the spread of contamination during the excavation of the low-level radioactive tailings-like material in the Industrial Area, the approximately 1,200-m^2 area will be surrounded by a berm, constructed to contain any contamination during rainfall events. The highest levels of radium contamination, located in the eastern portion of the old lagoon, likely represent only two or three truckloads. Procedural controls will ensure that this material is not excavated during precipitation events.

Since the low-level radioactive constituents in the low-level radioactive slag are immobile, low-level radioactive releases from this waste are not likely to occur during rainfall events.



NOTES:

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Ministry of the Environment
Ontario

CH2MHILL

PROJECT NO 119548

INTEGRATED CLEANUP PLAN
REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 6-2
PROPOSED LOCATION OF
WASH TRAILER AND WASH PAD

DWG NO
SCALE AS SHOWN
SHEET
OF
REV NO A

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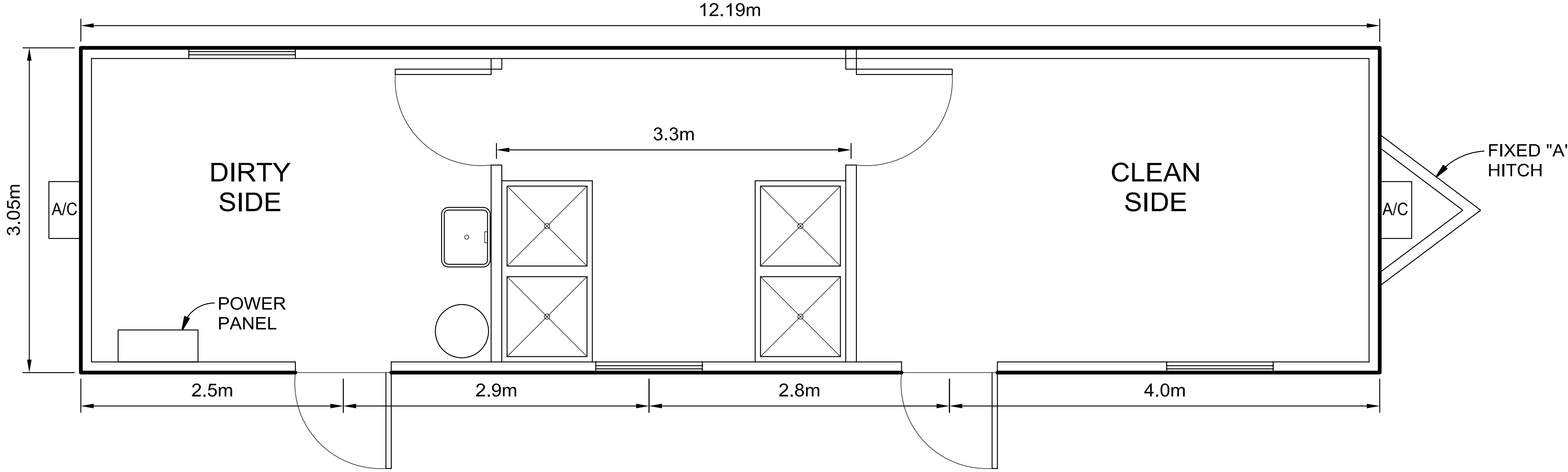

CH2MHILL

PROJECT No. 119548

INTEGRATED CLEANUP PLAN
REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 6-3
TYPICAL PERSONNEL
DECONTAMINATION TRAILER

6.6 Monitoring Program

A comprehensive monitoring plan will be required to evaluate the effectiveness of the cleanup measures and to identify the need for maintenance tasks discussed in the four area Closure Plans. The physical and chemical stability, water quality, and biological features at the Deloro Mine Site will be monitored in phases during two site rehabilitation time frames:

- Construction Phase
- OMM Phase

Monitoring may occur daily, weekly, monthly, or at other specified intervals. It is anticipated that sampling frequency will be gradually reduced as monitoring programs confirm the effectiveness of the rehabilitation measures in reducing the flux of arsenic migrating to the Moira River.

The results of monitoring during construction activities will be documented in a Site Closure Report. During the OMM phase, annual reports should be prepared that document the results of monitoring activities for that year, discuss past trends in the data, and forecast trends for the future. The overall effectiveness of the cleanup measures will be examined in the annual reports.

Various components associated with the monitoring program are described in detail below.

6.6.1 Existing Monitoring Programs

An extensive monitoring program is currently conducted by OCWA to monitor the quality of surface water, groundwater, and ATP effluent at the Deloro Mine Site. The current monitoring program (surface water, groundwater, pumping system, ATP inlet and outlet), is outlined in Tables 6.1 and 6.2. Surface water monitoring stations in the Moira River, Young's Creek, and their tributaries are indicated in Figure 6-4. The existing monitoring program will be extended to monitor the effectiveness of the site rehabilitation measures, and will continue through the Construction Phase at a minimum.

Arsenic Treatment Plant

The raw influent and final effluent from the ATP is analyzed for arsenic daily when the ATP is operating.

Pumping Stations

Groundwater samples are collected monthly from the six pumping stations (PS#1 to PS#6) and the two groundwater inspection holes and tested for aluminum, arsenic, cobalt, copper, lead, mercury, molybdenum, nickel, and zinc.

Groundwater Monitoring Program

Groundwater at the site has been sampled on a regular basis since 1988. Presently, there are 68 monitoring wells which are sampled quarterly. Most are analyzed for aluminum, arsenic, cobalt, copper, lead, mercury, molybdenum, nickel, zinc, pH, conductivity, and depth-to-water.

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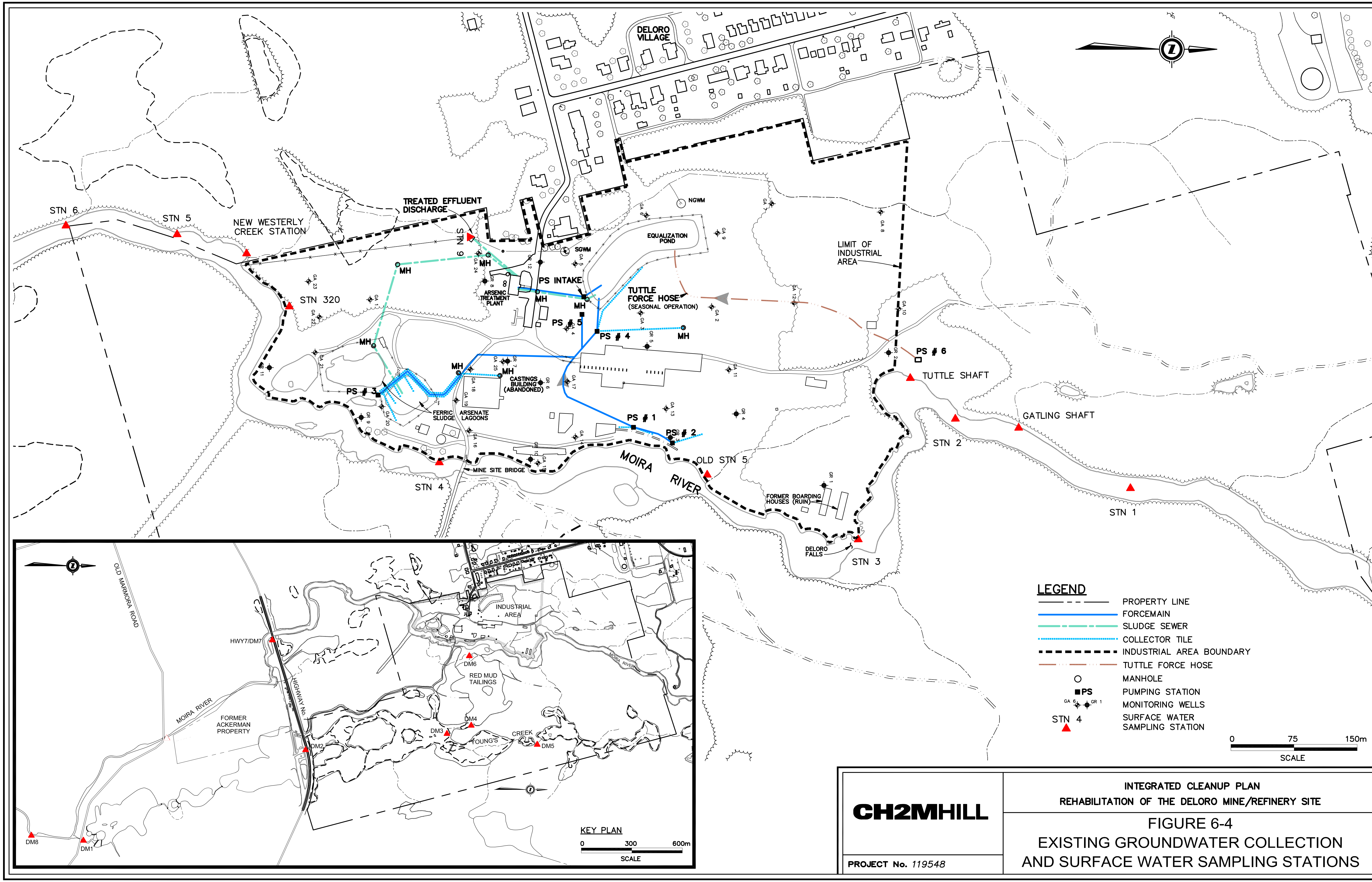

FIGURE 6-4
EXISTING GROUNDWATER COLLECTION AND SURFACE WATER SAMPLING STATIONS

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TABLE 6.1
SUMMARY OF EXISTING MOIRA RIVER MONITORING PROGRAM

Surface Water Sampling Stations	Parameters Analyzed/Measured								
	Al	As	Co	Cu	Hg	Mo	Ni	Pb	Zn
Stn 1	W	W	Q	Q	M	Q	W	Q	Q
Stn 2	W	W	Q	Q	M	Q	W	Q	Q
Stn 3	W	W	Q	Q	M	Q	W	Q	Q
Stn 4	W	W	Q	Q	M	Q	W	Q	Q
Stn 5	W	W	Q	Q	M	Q	W	Q	Q
Stn 6	W	W	W	W	M	Q	W	Q	Q
Stn 8	W	W	W	W	M	Q	W	Q	Q
DM 1	W	W	Q	Q	M	Q	W	Q	Q
DM 2	W	W	Q	Q	M	Q	W	Q	Q
DM 3	W	W	Q	Q	M	Q	W	Q	Q
DM 4	W	W	W	W	M	W	W	W	W
DM 5	W	W	Q	Q	M	Q	W	Q	Q
DM 6	W	W	W	W	M	W	W	W	W
Hwy 7/DM 7	W	W	W	W	M	Q	W	Q	Q
DM 8	W	W	W	W	M	W	W	Q	Q
Stn 320	W	W	Q	Q	M	Q	W	Q	Q
NWC	W	W	Q	Q	M	Q	W	Q	Q
Stn 9	W	W	Q	Q	M	Q	W	Q	Q
Tuttle Shaft	W	W	Q	Q	M	Q	W	Q	Q
Gatling Shaft	W	W	W	W	M	W	W	W	W

W = Weekly M = Monthly Q = Quarterly

TABLE 6.2
EXISTING MONITORING PROGRAM AT PUMPING STATIONS, MONITORING WELLS, AND ARSENIC TREATMENT PLANT

Sample Run	Frequency	Parameters Analyzed/Measured
Pumping Stations #1 – #6 SGWM NGWM	Monthly	Al, As, Co, Cu, Hg, Mo, Ni, Pb, Zn
Monitoring Wells GA 1-1 GR 1-1 GA 1-2 GR 1-2 GA 2-1 GR 2-1 GA 2-2 GR 2-2 GA 3 GR 3-1 GA 4 GR 3-2 GA 5 GR 3-3 GA 6 GR 4-1 GA 7 GR 4-2	Quarterly (if possible)	Al, As, Co, Cu, Hg, Mo, Ni, Pb, Zn, pH, conductivity, depth-to-water

TABLE 6.2
EXISTING MONITORING PROGRAM AT PUMPING STATIONS, MONITORING WELLS, AND ARSENIC TREATMENT PLANT

Sample Run		Frequency	Parameters Analyzed/Measured
GA 8	GR 5-1		
GA 9	GR 5-2		
GA 12-1	GR 5-3		
GA 12-2	GR 8-1		
GA 14	GR 8-2		
GA 15	GR 9-1		
GA 18	GR 9-2		
GA 19	GR 9-3		
GA 20	GR 10-1		
GA 21	GR 10-2		
GA 22	GR 11-1		
GA 24	GR 11-2		
GA 25	GR 12		
New Monitoring Wells		Quarterly (if possible)	Depth-to-water, temperature, pH, dissolved oxygen, conductivity, redox (EMF), Ag, Al, As, Ba, Be, B, Bi, Ca, Cd, Co, Cr, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Sb, Se, Si, Sn, Sr, Ti, Tl, Pb, U, V, Zn
MW-97-1			
MW-97-2			
MW-97-3			
MW-97-4			
MW-97-5			
MW-98-1D			
MW-98-1S			
MW-98-2D			
MW-98-2S			
97-TL-BH-1001			
97-TL-BH-1002			
97-TL-BH-1003			
97-TL-BH-1005			
97-TL-BH-1006			
97-TL-BH-1010			
97-TL-BH-1012			
97-TL-BH-1013			
97-TL-BH-1014			
98-TL-BH-1015			
98-6t-BH-6002		Quarterly (if possible)	Depth-to-water
98-6t-BH-6010		Quarterly (if possible)	Depth-to-water
98-6t-BH-6019		Quarterly (if possible)	Depth-to-water
98-6t-BH-6005		Quarterly (if possible)	Depth-to-water
98-6t-BH-6014		Quarterly (if possible)	Depth-to-water
Surface Water			
Moira River at Hwy 7 – 28 Day Sampler (Day 1 through 28)		Daily	As
Arsenic Treatment Plant		Daily (when plant is running)	As
Raw Influent			
Final Effluent			

Surface Water Monitoring Network

The surface water monitoring network, shown in Figure 6-4, comprises 20 sampling stations on the Moira River, New Westerly Creek, and Young's Creek that provide information on surface water quality upstream, downstream, and within the site boundary. A description of the 12 sampling stations which comprise the "Moira River Sample Run" is provided in Table 6.3. All stations are sampled weekly and analyzed for aluminum, arsenic, and nickel, with additional analyses for cobalt and copper at selected stations (see Table 6.1). Sampling frequencies for other parameters are summarized in Table 6.1. In addition, the Moira River at Highway 7 is analyzed for arsenic with a 28-day sampler that is repeated every 28 days.

TABLE 6.3
MOIRA RIVER MONITORING NETWORK

Station	Location
Stn 1	Station 1 is located on the river upstream of the Deloro Mine Site
Gatling	Samples are collected from the Gatling Shaft runoff to the river
Stn 2	Station 2 is located at the river between the Gatling and Tuttle Shaft stations
Tuttle	Samples are collected from the Tuttle Shaft runoff to the river
Stn 3	Station 3 is located downstream of the Tuttle Shaft and above the falls east of the boarding house ruins
Stn 4	Station 4 is located immediately upstream of the weir south of the mine site bridge
DM 6	Samples are collected from the runoff west of the concrete west tailings dam wall
Stn 320	Samples are collected from the runoff through the old equalization pond and dump
NWC	Samples are collected from the New Westerly Creek runoff to the river
Stn 5	Station 5 is located approximately 100 m downstream of the New Westerly Creek station
Stn 6	Station 6 is located approximately 200 m downstream of Station 5
Hwy7/DM7	Highway 7 and the Moira River represents the downstream point for the Moira River; DM7 represents the upstream Moira River point for Young's Creek contribution

A synopsis of the monitoring program that will be completed at the Deloro Mine Site in addition to the existing monitoring program is summarized in Table 6.4. Details of the monitoring for each area are discussed in their respective Closure Plans. The monitoring program for each area stipulates monitoring requirements during the shorter-term rehabilitation/construction stage, as well as for the longer-term post-closure stage.

TABLE 6.4
SUMMARY OF PROPOSED SUPPLEMENTAL MONITORING PROVISIONS

Type of Monitoring	Description	Duration	Frequency
Physical Stability	Visual inspection of vegetative covers, for erosion problems, tension cracks, seeps	Indefinitely following containment and capping	Semi-annual for years 0 to 3 Annual after year 3
Water Quality	Sampling and analysis of surface water at key selected locations in addition to the existing surface water monitoring network	During the excavation stages of the project	Weekly during excavation
Water Quality	Sampling and analysis of surface water at key selected locations	Indefinitely following containment and capping	Semi-annual for years 0 to 5 Annual after year 5
Leachate Quality	Sampling and analysis of leachate at collection locations	Indefinitely following containment and capping	Semi-annual for years 0 to 5 Annual after year 5
Groundwater	Sampling and analysis at selected monitoring wells at the property line or downgradient of waste isolation areas	Indefinitely following containment and capping	Quarterly for years 0 to 5 Annual after year 5
Groundwater	Water level monitoring and water quality at performance monitoring locations near the groundwater interceptor well network and extraction wells	Indefinitely following installation	Monthly until steady state conditions reached Quarterly after steady-state conditions reached
Flow Monitoring	Groundwater interceptor and extraction well flows	Indefinitely	Monthly
Pumping and Conveyance	Visual inspections and pressure testing	Indefinitely throughout the pumping period	Monthly (with alarms in place)
Sediment and Soil Quality	Confirmatory sampling and analysis of sediment and soil quality of excavation floor (as appropriate), to verify cleanup in Young’s Creek	During the excavation stages of the project	30 m by 30 m grid
Biomonitoring	Plant health/ condition and contaminant uptake; Wildlife observation/ surveys	Indefinitely	Once every 5 years for the first 20 years Once every 10 years thereafter
Arsenic Treatment Plant	As per existing program outlined above	Throughout the construction and OMM phase	As per existing monitoring program outlined above for years 0 to 5 Frequency reviewed after 5 years and reduced if possible

6.7 Site Management

It is anticipated that the proposed rehabilitation alternatives will achieve the expected conditions and uses in the long-term. As part of a long-term site management program, it is anticipated that the following measures will be implemented or maintained:

- Fencing exists on the perimeter of the Deloro Mine Site and access is restricted to authorized personnel
- Signage exists on the perimeter fence as well as at the north and south approaches along the Moira River
- The MOE will retain ownership and control of the site for the foreseeable future
- Site conditions will be registered on title at the conclusion of the cleanup coincident with the issuance of a Record of Site Condition (RSC)

The mitigation measures outlined in the Closure Plans will be addressed in the event that design malfunctions and/or accidents occur.

7. Approval Requirements

The primary site-wide regulatory approvals that must be applied for and issued by the appropriate government agencies for one or more areas of the site are outlined in this section of the ICP.

7.1 Site-Specific Risk Assessment

SSRA is the remedial approach selected from the options available in the GUCSO (MOE, 1997). There are a number of steps to approval of an SSRA to ensure that public health and the environment are protected. First, an SSRA is reviewed by an independent third-party peer reviewer who is qualified and experienced in conducting SSRAs. Once the peer reviewer's comments have been incorporated, the SSRA is submitted to the SDB of the MOE, which undertakes a review of both technical and policy issues. Other prerequisites for acceptance of the SSRA include community-based public communication and dialogue with the municipality regarding the SSRA. Once these steps have been completed, the cleanup can proceed.

As confirmation that the actual cleanup is completed according to the SSRA, a RSC will be prepared and filed to document the cleanup. The RSC is completed jointly by the proponent, MOE, as well as the consultant overseeing the cleanup. The SSRA is a Level 2 Risk Management involving the use of engineered controls (i.e. engineered covers, groundwater pumping/treatment systems). A Level 2 Risk Management requires Registration on Title for the property to document the conditions of the land in the public domain. Registration on Title will be accomplished through filing a Certificate of Prohibition.

As a result of the different land ownership between the Deloro Mine Site and the Young's Creek Area south of Highway 7, a separate SSRA report has been prepared for each of these two land parcels (see Section 2.1.2).

The current process for completing SSRAs, outlined above, was developed in 1997 and has been in place since that time. New legislation has been passed that is anticipated to modify this process once the enabling regulations are finalized. The new legislation, the *Brownfield Law Statutes Amendment Act*, received Royal Assent on November 21, 2001 and the public comment period for the regulations ended on April 29, 2003. Final regulations, which come into effect on October 1, 2004, change the SSRA process from a guideline-driven to a regulatory-driven process. The new regulations do not suggest significant change in the technical approach to SSRAs, but they do indicate some changes in the administrative aspects. The Deloro Mine Site SSRA will be adapted, if needed, to meet the new regulatory requirements.

7.2 MOE Authorizations

Under the *Environmental Protection Act* (EPA) and the *Ontario Water Resources Act* (OWRA), approval is required from the MOE for processes that emit to the environment or for waste management activities. The primary means of approval is through issuance of a C of A for air or water emissions or a Provisional Certificate of Approval (PC of A) for waste related

activities. A Permit to Take Water (PTTW) is required for water extraction above 50,000 L/day. Generator registration is required for ongoing waste generation, such as the ferric arsenate sludge, which is generated by the onsite ATP.

A number of MOE authorizations already exist at the Deloro Mine Site as a result of environmental mitigation actions implemented to date. This includes extraction and pumping of impacted groundwater, treatment of water in the ATP, discharge of the treated effluent, and storage/dewatering of sludge from the treatment process. A listing of the MOE authorizations currently in place at the Deloro Mine Site is provided in Table 7.1.

The Closure Plans will result in changes to the currently authorized systems, plus the addition of new systems. Changes to the current systems will require modifications to the existing MOE authorizations, most likely through an amendment (i.e. C of A amendment). New systems will require new authorizations to be developed.

7.2.1 Certificate of Approval – Sewage

Amendment to the existing C of A for the ATP, sludge storage lagoon, pumping stations, and forcemains may be required to accommodate modifications to these systems as a result of the Closure Plans.

7.2.2 Certificate of Approval – Air

There is no anticipated requirement for modification of the existing C of As or to obtain new C of As as a result of the Closure Plans.

7.2.3 Permit to Take Water

The existing PTTW for the Tuttle Shaft pumping station will require amendment to account for installation of a permanent forcemain and the increase in pumping to year-round operation. Other PTTWs for the other pumping stations may also require some modifications.

In the Industrial Area, a new PTTW will be required to authorize the construction and operation of a groundwater interceptor system at the western property line. Similarly, a new PTTW will be needed in the Tailings Area for groundwater pumping from wells located in the vicinity of the two tailings dams.

7.2.4 Provisional Certificate of Approval – Waste Disposal

The site cleanup is following the SSRA process (outlined above) where existing residuals and by-products will be managed onsite through a Level 2 Risk Management involving isolation and containment. Although the legacy materials being managed have been in place for several decades and are not the result of ongoing waste production and many of the materials are the result of mining activities (i.e. mill tailings from a mine) that are exempt from Ontario’s Waste Management Regulation, the MOE has committed to seeking a PC of A for the proposed waste management facilities under Part V of the EPA. The development of Closure Plans for the Deloro site has drawn on landfill design standards, as well as mine closure and other guidelines, as general guidance and best management practices to ensure that the site is engineered and maintained to be safe and secure for hundreds of years.

TABLE 7.1
EXISTING MOE AUTHORIZATIONS FOR THE DELORO MINE SITE

Authorization	Type	Number	Date	Description
Certificate of Approval	Sewage	4-036-82-006	28 Jul 1982	Collection/storage/ treatment system
Certificate of Approval	Air	8-4042-82-006	8 Sep 1982	Lime silo venting and fume hood exhaust
Certificate of Approval	Sewage	4-053-83-006	18 Jul 1983	Pumping station and forcemain
Provisional Certificate of Approval	Waste Disposal Site	A362106	6 Sep 1983	Temporary storage processed sludge
Permit	Permit to Take Water	85-P-4006	26 Apr 1985	Tuttle shaft and pumping station #5
Certificate of Approval	Sewage	4-041-85-006	25 Jul 1985	Sludge drying lagoon
Permit	Permit to Take Water	85-P-4038	16 Aug 1985	Moira River
Certificate of Approval	Sewage	4-067-85-006	16 Sep 1985	Inspection hole rehabilitation
Certificate of Approval	Air	8-4069-86-006	17 Nov 1986	Plant exhaust system
Certificate of Approval	Sewage	4-116-86-876	8 Jul 1987	Tuttle shaft pump and forcemain
Certificate of Approval	Sewage	4-0155-87-006	20 Nov 1987	Sludge testing lagoon
Certificate of Approval	Air	8-4120-88-006	12 Dec 1988	Lab equipment exhaust
Generator Registration	Waste Streams	ONO199886	23 Jan 1989	Arsenic compounds and oils
Certificate of Approval	Air	8-4128-89-006	4 Dec 1989	Lab fume hood exhaust
Permit Amendment	Permit to Take Water	83-P-4010	6 Jun 1990	Pumping station #3
Permit Amendment	Permit to Take Water	82-P-4035	6 Jun 1990	Pumping stations #1, #2, and #4
Certificate of Approval Amendment	Industrial Sewage	4-041-85-006	27 Nov 1992	Sludge storage lagoon expansion
Permit Amendment	Permit to Take Water	85-P-4006	21 Feb 1996	Tuttle shaft and pumping station #5
Certificate of Approval Amendment	Industrial Sewage Works	4-036-82-006	20 Apr 2000	Decontamination facilities
Generator Re-registration (HWIN)	Waste Streams	ONO199886	Jan 2002	Ferric arsenate sludge
Provisional Certificate of Approval	Waste Disposal Site	2668-5DHJEW	30 Aug 2002	Temporary storage contaminated soil
Provisional Certificate of Approval Amendment	Waste Disposal Site	2668-5DHJEW	12 Nov 2002	Contingency plan
Permit Amendment	Sewage	4-041-85-006	24 Jun 2004	Sludge drying lagoon

The Deloro Mine Site Cleanup Project is being carried out under an exemption to the provincial *Environment Assessment Act* (EAA). Ontario Regulation 577/98 (O.Reg 577/98) exempts the Deloro Mine Site Cleanup Project from a mandatory hearing under Part V of the EPA (Sections 30 and 32).

7.3 Conservation Authority

Through the *Fill, Construction, and Alteration to Waterways Regulation*, which is administered in support of Section 28 of the *Conservation Authorities Act* of Ontario, the Conservation Authority regulates and may prohibit work taking place within valley, river, stream, and watercourse corridors as well as along lake waterfronts.

Fill regulations allow the Authority to prohibit or regulate the placing, excavation, grading, or dumping of fill of any kind for projects such as pools, ponds, roads, and driveways. These regulations are applied when, in the opinion of the Authority, the control of flooding, pollution, or the conservation of land within its jurisdiction may be affected by the placing or dumping of fill.

Construction regulations allow the Conservation Authority to regulate construction in or on a wetland or floodplain, or in any area susceptible to flooding during a regional storm. In this regulation, construction refers to new buildings, additions to existing buildings, stormwater outfalls, culverts, and bridges.

The alteration to waterways regulations allow the Conservation Authority to prohibit or regulate straightening, changing, diverting, or interfering with the existing channel of a river, creek, stream, or watercourse.

Based on the remedial works that are proposed along the west bank of the Moira River (reconstruction) as well as within Young's Creek (sediment and soil removal, and wetland rehabilitation), it is anticipated that a permit "To Construct, Place Fill, or Alter a Waterway" will be required from the Moira River Conservation Authority (MRCA) care of Quinte Conservation (QC).

7.4 Ministry of Natural Resources

Of note within the Deloro Mine Site property and in the Young's Creek Offsite Area is a PSW, the Deloro Wetland Complex. The Deloro Wetland Complex, including the area along Young's Creek south of Highway 7, was evaluated during the summer of 2000 using the 3rd Edition of the wetland evaluation manual (Snider's Ecological Services, 2000). The wetland received a total score of 688 and was evaluated as a Class 2 PSW.

The management of Ontario wetlands and lands adjacent to them is implemented through the *Wetlands Policy Statement,* which falls under the jurisdiction of the *Planning Act*. The MNR and the Minister of Municipal Affairs jointly issued the *Wetlands Policy Statement*. The policy requires that all planning jurisdictions protect PSWs such that development is not permitted in PSWs that are located within the Great Lakes—St. Lawrence Region. Development and alteration may be permitted on lands adjacent to PSWs only if it does not result in:

- Loss of wetland function
- Subsequent demand for future development that will negatively impact existing wetland functions
- Conflict with existing site-specific management practices
- Loss of wetland area

An Environmental Impact Study (EIS) would have to be prepared in order to permit development on these adjacent lands.

Consultation is required with the MNR, and possibly the Minister of Municipal Affairs, to determine whether any of the project components, such as construction of the Young's Creek Area onsite containment cell and dredging, constitutes wetland "development" and whether the project can be permitted. Also, the MNR would need to determine whether an EIS would need to be completed.

The MNR is also responsible for issuing Work Permits under the authority and provisions of several different Provincial Acts. If the project is allowed to proceed, the Provincial Acts that apply to this project would have to be determined in consultation with the MNR. The following Provincial Acts and their regulations are considered in the application for a Work Permit.

Forest Fire Prevention Act*:* The MNR administers this Act. A Work Permit is required to authorize any work on Crown land and to ensure that adequate forest fire precautions and equipment are in place.

Lakes and Rivers Improvement Act: The purpose of this Act is to manage the use of the lakes and rivers in Ontario and to regulate improvements to them. The Act provides for the preservation of public rights in or over water; protection of the interests of riparian owners; management of fish, wildlife, and other natural resources dependent on such waters; preservation of natural amenities; and suitability of the location and nature of improvements. The *Lakes and Rivers Improvement Act* gives the MNR the mandate to manage water-related activities, particularly in the areas outside the jurisdiction of Conservation Authorities.

Public Lands Act*:* This Act, which is administered by the MNR, authorizes the construction of roads on Crown lands, sets out Crown cost-sharing of company roads, identifies limitations on liability and tenure for private forest roads and camp areas, and defines the applicability of the *Highway Traffic Act* on access roads.

As part of the application for a Work Permit, each project proponent must complete and apply for "Parts" of the permit. The determination of which Parts (i.e. A through F) are applicable to the project is conducted in consultation with the MNR. The Parts that must be taken into consideration when applying for a Work Permit are briefly described below:

- *Part A*: Fire Prevention and Suppression/Logging Activities
- *Part B*: Mineral Exploration Activities
- *Part C*: Building Construction
- *Part D*: Application to do Work on Shore Lands
- *Part E*: Roads, Trails, or Water Crossings
- *Part F*: Works Within a Waterbody

Based on the work proposed at the Deloro Mine Site, a Work Permit will be required from the MNR. Several Parts to the application will have to be completed possibly including, but not limited to, Parts A, D, and F. It is anticipated that the MNR will include conditions pertaining to work in the PSW with those issued as part of the Work Permit.

7.5 Department of Fisheries and Oceans/ Canadian Coast Guard

7.5.1 Navigable Waters Protection Act (NWPA)

The purpose of the NWPA is to protect the public right to marine navigation and to ensure unobstructed passage of vessels in Canadian waters. Any construction, modification, or repair of a work that will interfere with navigable waterways must be approved or concurrence provided by the federal Department of Fisheries and Oceans (DFO) and is administered by the Canadian Coast Guard (CCG). The removal of obstructions to navigation, and the provision and maintenance of lights and markers required for safe navigation is also covered under this Act. Although the section of the Moira River that passes through the site has limited use for boating, many parts of the Moira River are navigable and the CCG should be consulted on the final Cleanup Plan for the site.

7.5.2 Fisheries Act

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the federal *Fisheries Act*. The *Fisheries Act* protects and conserves fish and fish habitats, and has the power to deal with damage to fish habitat, destruction of fish, obstruction of fish passage, necessary flow requirements for fish, and the control of deleterious substances. Section 35(1) of the federal *Fisheries Act* states that “no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat” (HADD). Any proposed works and activities that are likely to alter or damage fish habitat must be reviewed and authorized by the DFO. The Conservation Authorities have agreements with the DFO in the evaluation and processing of applications and therefore would also have to be consulted.

It is important to note that the DFO has also developed a Policy for the Management of Fish Habitat that includes a No Net Loss guiding principle. This principle is applied to any proposed development that would result in a loss of productive fish habitat. The regulatory agency would review the measures to determine if they meet not only the No Net Loss of fish habitat, but also the DFO’s long-term policy objective of achieving an overall net gain of the productive capacity of fish habitats. Therefore, works requiring an authorization from the DFO typically includes a Fisheries Compensation Plan that describes the measures taken to realize an overall net gain in the productive capacity of fish habitats as a result of the project.

A section of the west bank of the Moira River in the Industrial Area will be reconstructed, and a significant amount of work is proposed within Young’s Creek including the excavation of contaminated sediment/soil and wetland rehabilitation. As this will affect fish habitat, a *Fisheries Act* authorization will be required and a Fisheries Compensation Plan may have to be prepared. In addition, application for a blasting permit may be required to address “destruction of fish by any other means” (under the *Fisheries Act*), since a portion of the onsite containment cell will be located in Young’s Creek and will require blasting during its construction.

7.6 Environmental Assessment and Canadian Nuclear Safety Commission Licensing

The *Nuclear Safety and Control Act* (NSCA) mandates the Canadian Nuclear Safety Commission (CNSC) to regulate all aspects of the nuclear industry in Canada, including the management and isolation of nuclear wastes. Paragraph 26 of the NSCA states that:

> *Subject to the regulations, no person shall, except in accordance with a licence,…possess…manage, store or dispose of a nuclear substance. . .*

It is with respect to this paragraph that the MOE seeks to obtain a licence to manage and store, at various locations on the Deloro Mine Site, the low-level radioactive wastes present on the site. Conceptual waste isolation scenarios are presented in this report and in the four Closure Plans for low-level radioactive (and non-radioactive) materials.

CNSC's authorization of the project would be provided through the issuance of a Waste Nuclear Substance Licence (WNSL) for the possession, management and storage of nuclear substances, pursuant to subsection 24(2) of the NSCA.

As previously noted, because nuclear waste management and storage is a physical activity listed in the "Inclusion List Regulation" of the *Canadian Environmental Assessment Act* (CEAA), the proposed project is subject to the federal Environmental Assessment (EA) process. Therefore, the licensing and the federal EA processes are closely linked, as explained below.

The screening level EA process being followed for this project is outlined in Section 8.4. At the completion of the EA study, the proponent must summarize the process and the results of the EA into a report that is submitted to the responsible authority (RA) for its review. Once the RA is satisfied that the EA has met the initial scope, the report is then submitted to the members of the CNSC for its approval. A hearing in which the proponent presents the project and where the public is invited to voice its concerns or support may be required.

Following the approval of the results of the EA by the CNSC, an application for a WNSL must be formally submitted by the proponent in accordance with the *General Nuclear Safety and Control Regulations* and *Nuclear Substance and Radiation Devices Regulations* of the NSCA. A WNSL is applicable, as opposed to a Class Ib Nuclear Facility Licence, because mainly chemical wastes are being managed with the presence of some radioactive materials.

As part of the application for a WNSL, safety analyses must be conducted to ensure radiation exposures to both workers and the public are acceptable during normal and abnormal conditions at the site.

Some applicable portions of the *General Nuclear Safety and Control Regulations* which must be addressed in the application are as follows:

> 3 (1) (*e*) the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*;
> (*f*) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*;
> (*g*) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;
> (*h*) the proposed measures to prevent loss or illegal use, possession

> or removal of the nuclear substance, prescribed equipment or prescribed information;
> (*i*) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;
> (*j*) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;

Some applicable sections of the *Nuclear Substance and Radiation Devices Regulations* are as follows:

> **3.** (1) An application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*:
> (*a*) the methods, procedures and equipment that will be used to carry on the activity to be licensed;
> (*b*) the methods, procedures and equipment that will be used while carrying on the activity to be licensed, or during and following an accident, to
> (i) monitor the release of any radioactive nuclear substance from the site of the activity to be licensed,
> (ii) detect the presence of and record the radiation dose rate and quantity in becquerels of radioactive nuclear substances at the site of the activity to be licensed,
> (iii) limit the spread of radioactive contamination within and from the site of the activity to be licensed, and
> (iv) decontaminate any person, site or equipment contaminated as a result of the activity to be licensed;
> (*c*) a description of the circumstances in which the decontamination referred to in subparagraph (*b*)(iv) will be carried out;

Following submission of the application and any clarifications and/or additional materials required by CNSC staff, a draft licence is then prepared by CNSC staff, discussed with the proponent, and ultimately presented to the members of the CNSC for approval. A hearing in which the proponent presents its application and where the public is invited to voice its concerns or support may be required. Upon acceptance, a WNSL is issued and remedial work can begin under the conditions of the licence.

7.7 Mining Act

The regulatory considerations relevant to the Deloro project were examined early in the project and have been refined as the project has progressed. The document entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998) summarized the application of the *Mining Act* to the Deloro project. Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act*, the Closure Plans have been developed to satisfy, in general, the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The Ministry of Northern Development and Mines (MNDM) has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

8. Remaining Stage One Tasks

Section 8 provides an overview of the main project tasks which must be completed in Stage 1 (investigation, engineering, and approvals) leading up the start of Stage 2 of the project (tendering and construction). The remaining project tasks and projected schedule for completion of Stage 1 is provided in Figure 8-1.

8.1 Ministry of the Environment's Public Consultation Program

Part of the MOE's commitment to dealing with the problems posed by the abandoned Deloro Mine Site includes close contact and consultation with those groups, agencies, and individuals who are potentially affected by their proximity to the site.

A communications plan was initiated January 1996 to:

- Inform and educate stakeholders about the multi-year, multi-phased rehabilitation project for the Deloro Mine Site
- Involve the community and solicit public input as part of the provincial *EAA* exemption, and *EPA* approval processes required during the project

The plan includes various vehicles for public involvement and information sharing, including:

- Local update bulletins to keep the community informed of progress at the site (these updates are hand-delivered to Deloro residents)
- Establishing three liaison committees: a Public Liaison Committee (PLC), a Technical Liaison Committee (TLC), and a MOE Technical Committee (MTC). Since 1997, the MOE has been meeting regularly with the three project liaison committees to keep them informed and to gather input and comments on reports and recommendations. This consultation process helps to inform and guide the MOE's remediation plans and work at the site, and down-river

Details regarding the MOE's consultation program were outlined in the *Deloro Mine Site Cleanup – Project Description, Final Report* (CH2M HILL, November 2002). The following sections highlight and provide updated information regarding the consultation program.

8.1.1 Public Liaison Committee

The PLC includes representatives from municipal, environmental, and public stakeholder groups in the Deloro/Moira River area:

- Village of Deloro (residents)
- Municipality of Marmora and Lake
- Municipality of Centre Hastings

Figure 8-1
Projected Schedule to Complete Stage 1

Updated 11/05/2004

Deloro Mine Site Cleanup

- Quinte Watershed Cleanup
- Quinte Field Naturalists
- QC/MRCA
- Moira Lake Property Owners' Association
- Stoco Lake (residents)
- Mohawks of the Bay of Quinte
- Deloro Heritage Initiative Committee
- Marmora Historical Foundation
- City of Belleville

8.1.2 Technical Liaison Committee

The members of the external TLC represent municipal, provincial, and federal agencies with an interest in, or regulatory involvement with, the site:

- Atomic Energy of Canada Limited
  - Low-Level Radioactive Waste Management Office
- CCG
- Environment Canada, Ontario Region
- DFO
  - Fisheries and Habitat Management Branch
- Hastings and Prince Edward Counties Health Unit
- MOE
- Ministry of Health and Long-Term Care
- Ministry of Labour
- MNR
- MNDM
- QC/MRCA
- OCWA
- CNSC (Effective July 2004)

8.1.3 Ministry of the Environment Technical Committee

The MTC is made up of representatives from the MOE's technical branches. Representatives provide advice on technical and regulatory requirements:

- Eastern Region Water Resources Unit
- Eastern Region Abatement Section
- Standards Development Branch
- Environmental Cleanup Fund
- Legal Services Branch
- Water Policy Branch
- Environmental Assessment and Approvals Branch
  - Waste Section

8.1.4 Deloro Mine Site Cleanup Project Web Site

The MOE has a Web site dedicated to the Deloro Mine Site Cleanup Project (http://www.ene.gov.on.ca/envision/deloro/index.htm), so that those with an interest in the project have easy access to information.

8.1.5 Other Communications

In addition to regular consultation with liaison committees and residents, significant communications activities were developed for the release of the *Deloro Village Environmental Health Risk Study* in July 1999, the release of the draft *Moira River Study* for public consultation in August 2000, and the release of the final version of the *Moira River Study* in April 2001.

The MOE has also assisted the CNSC in its efforts to consult with the Deloro community and project liaison committees, on certain aspects of the CEAA requirements. The CNSC is responsible for some aspects of public consultation on the EA, maintains a public record on this project, and posts all information relevant to decision-making on its Web site.

8.2 Public Consultation on the Draft Proposed Cleanup Plan

The MOE is committed to public consultation on the draft proposed Cleanup Plan for the site. Consultation is also a requirement of the provincial EAA exemption, the EPA approval processes, as well as a requirement of the CEAA. The public consultation strategy has been vetted through the CNSC as a requirement of the CEAA.

On July 21, 2004 the MOE initiated consultation on CH2M HILL's draft proposed Cleanup Plan. Consultation began with the three project liaison committees at a joint workshop at the Marmora Community Centre.

The liaison committees were given the first opportunity to review the consultant's draft. The workshop ran from 9:00 a.m. to 5:00 p.m., and included detailed presentations on the draft Cleanup Plan. Smaller break-out sessions were used to facilitate dialogue. About 50 people attended the event.

The draft ICP (Version 1) was provided to all liaison committee members. They were invited to review the report and provide comments by the end of September 2004. All comments were provided to CH2M HILL for their review and consideration.

The MOE has prepared a written summary of the comments noted at the July 21, 2004 joint workshop and the comments received in writing following the workshop to explain how the comments received were considered and incorporated.

Full public consultation on the MOE's draft proposed Cleanup Plan for the Deloro Mine Site will begin in November 2004. Residents of Deloro will receive a full information package. Residents along the Moira River downstream of the Deloro Mine Site will also be provided with an information package and an invitation to review the draft proposed Cleanup Plan. The information package will contain a summary report of the draft proposed Cleanup Plan, as well as a number of communications products, all designed to help explain the

details of the report. Public consultation will be open to anyone with an interest in the project and will be broadly announced.

The MOE will post the draft proposed Cleanup Plan and other related materials to its Web site for ease of access. As part of the broader public consultation, the MOE will host a public information session to explain the draft proposed Cleanup Plan, answer questions, and gather input. The public will also be encouraged to provide comments in writing over a 60-day comment period. All comments will be reviewed by the MOE and its consultants. The MOE will produce a written document to explain how comments were considered and incorporated.

8.3 Ongoing Communications

Once public consultation on the draft proposed Cleanup Plan is complete and a final report produced, the MOE will continue to actively communicate to its liaison committees and the public. Liaison committee meetings will continue to be held on a quarterly basis to provide project updates and to solicit feedback on the project before, during, and after construction activities.

8.4 Complete the Environmental Assessment

The MOE is seeking the necessary approvals to undertake a project involving the long-term onsite management of historic wastes, contaminated soils, and low-level radioactive wastes currently located at and in the vicinity of the Deloro Mine Site. The MOE understands that the licensing requirements for radioactive materials management under the NSCA require that an EA under the CEAA be completed.

The report entitled *Deloro Mine Site Cleanup – Project Description, Final Report* (CH2M HILL, November 2002) provided the appropriate federal authorities with a project description and related information to initiate the federal EA process under the CEAA. The CNSC, in co-operation with the DFO, subsequently prepared a document entitled *Environmental Assessment Guidelines (Scope of Project and Assessment), Environmental Assessment of the Deloro Mine Site Cleanup, Deloro, Ontario* (CNSC, October 2003). This document provided specific direction to the proponent, MOE, for the conduct and documentation of the technical EA study report, the responsibility for which was delegated to them by the CNSC and DFO pursuant to subsection 17(1) of the CEAA. The EA guidelines also provided a means of communicating the EA process to stakeholders.

CH2M HILL is in the process of completing the EA which will culminate in the preparation of an EA study report. VECs and Valued Social Components (VSCs) have been identified and stakeholders have been consulted to reach a consensus on this component of the EA. EA criteria are being developed and will also be the subject of stakeholder consultation. Completion of the public consultation outlined above is a critical component of the EA and a prerequisite for completion of the EA study report. Some of the supplemental studies proposed for the SSRA will also provide important information for the EA. While the EA has been initiated, the information from the ongoing efforts to finalize design information and technical analysis, particularly the supplemental SSRA, will be needed to complete the EA study report. Once finalized, the EA study report will be submitted to CNSC. CNSC

staff will then proceed to prepare an Environmental Screening Report which documents their recommendations to the CNSC Commission. The EA will conclude with a decision by the CNSC Commission.

8.5 Finalize Design Information/Analysis

8.5.1 Revise/Update Site-Specific Risk Assessment

The SSRAs provided to the MOE documented the presence of metal contaminant-related issues within the Deloro mine onsite area and Young's Creek offsite area under the post-closure conditions for the recommended rehabilitation alternatives. While the SSRA results did not show unacceptable risk under most conditions, it also indicated that there were potential risks to plants and animals residing within these areas, as well as to humans spending time on the respective properties, in some circumstances. The extensive characterization work at the site has focused on the areas requiring remediation, with less effort directed to areas that will remain post-closure. As a result, the data used to define the nature and extent of post-closure contamination and subsequent risk, or to establish acceptable risk-based cleanup levels, is being augmented through further investigative work. Further, the conclusions for potential risks to ecological receptors/VECs were primarily based on published reference values consistent with a screening level risk assessment (e.g. GUCSO, MOE 1997). These values are not specific to this site, the activities that have taken place, or the types of contaminants present. In order to confirm that the recommended alternatives are appropriate and that remediation is not required over a broader area of the site (beyond the areas identified in the Closure Plans), additional site information is being collected and further risk evaluation is underway.

The results of the supplementary site information and risk assessment will be used to fill in the data gaps, increase the confidence in the risk evaluation, and update the draft results of the HHRA and SLERA for both the Deloro Mine Site SSRA report and the Young's Creek Offsite SSRA report. The revised reports will be prepared in a format that is suitable for submission to first a third-party peer reviewer then to SDB of the MOE for their review following the additional work. If necessary, the Closure Plans will be revised to address additional areas of the site that need to be capped or excavated.

The following briefly lists the studies that are planned or ongoing to verify and substantiate the conclusions of the SLERA and the HHRA:

- Additional chemical characterization of onsite soil, sediment, and surface water
- Collection of biota co-located with soil, sediment, and surface water samples for evaluation of site-specific bioaccumulation
- Biological and physical surveys within the Young's Creek onsite area
- Toxicity testing of the Young's Creek onsite area
- Bioavailability of COCs in soil, sediment, and surface water

It is expected that the supplemental studies will be completed through the Spring and Summer of 2005, followed by updating the SSRA analysis and reports through the Fall of

2005 and the winter of 2005/2006, if required. The SSRA will be finalized following independent third party, and later SDB, review.

8.5.2 Groundwater Interceptor Well Network Program

Considerable engineering and hydrogeological evaluation has been undertaken to support the development of a passive GIWN to divert unimpacted groundwater around the contamination present largely in the Industrial Area. A conceptual design is presented in the Industrial Area Closure Plan which is supported by detailed groundwater flow simulations. Given the critical nature of the GIWN for the success of the overall Closure Plan, it is recommended that a focused hydrogeological program be undertaken now to confirm the design parameters and forecasted performance for the GIWN, thereby improving the overall confidence in this recommended conceptual approach.

The focused hydrogeological program will involve installing pilot groundwater extraction wells and completing pumping tests which will be used to refine the conceptual design and ultimately a final design. The pilot groundwater extraction wells will be incorporated into the final GIWN. The focused hydrogeological program will be completed through 2005. Stakeholder updates will be provided as further information becomes available.

8.5.3 Finalize Cleanup Plans

It is anticipated that the Cleanup Plans will be finalized, subject to the future conclusions of the draft SSRA, following the end of the broader public consultation. Comments and concerns raised during the consultation program will be addressed together with the results of ongoing efforts to finalize technical information and analysis. This is expected to occur in early 2005.

8.5.4 Approvals

Following the finalization of the ICP, it will be submitted to the regulatory bodies (e.g. MOE Approvals Branch, MNDM, CNSC, other bodies as identified by the RA, and municipal authorities) for approvals. Key components of this phase are listed below and described in greater detail in Section 7:

- SSRA Peer Review and SDB Review
- Waste Nuclear Substance Licence
- Certificate of Approval
- Other Permits/Authorizations

The current schedule shows that these activities will be initiated through early 2005. A period of one year has been allocated to obtain all necessary approvals.

8.5.5 Design

Design developments and refinements will continue through the period leading up to construction. Detailed designs and specifications will be developed to support approvals and will be finalized prior to tendering and construction. Detailed design will commence in early 2005 and be completed through the summer of 2006.

8.5.6 Stage 2 – Implementation

The start of Stage 2 – Implementation commences with the tendering period which is currently forecasted for mid-2006. Tender packages will be developed with the Shared Services Bureau of the MOE. This will be conducted in such a way that it will be possible to issue a call for tenders for the cleanup work shortly after the delivery of the necessary permits and C of As.

9. References

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